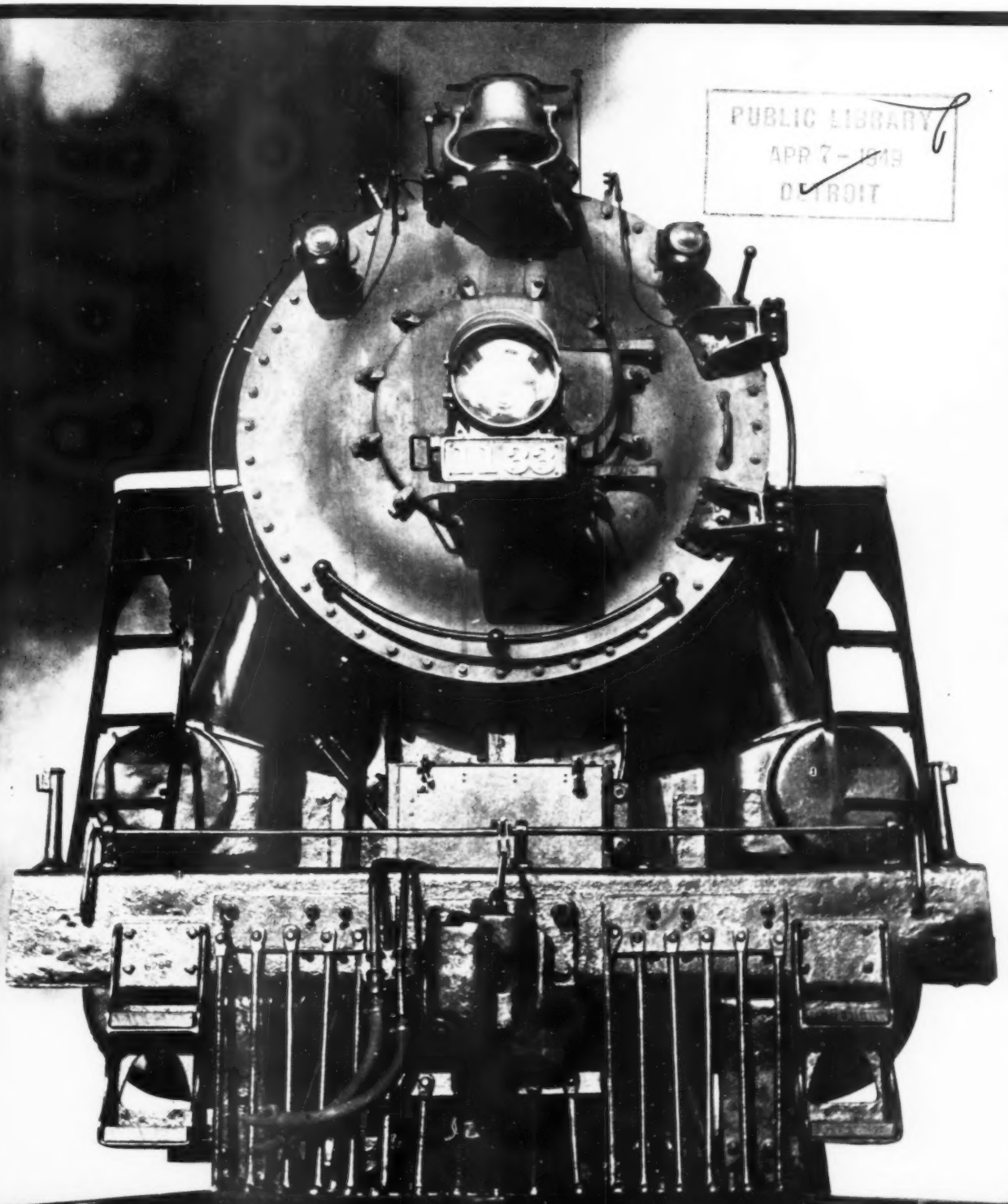
TECHNOLOGY REVIEW

April 1949



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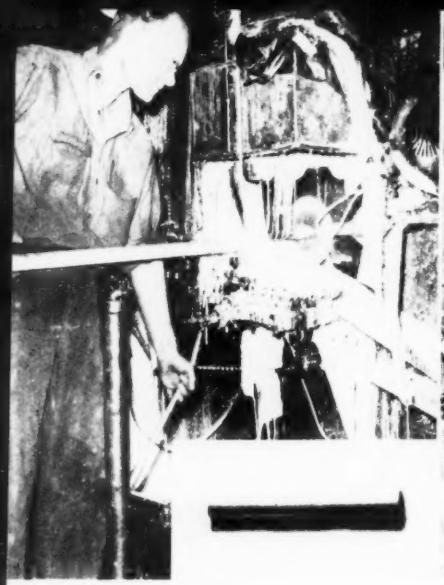
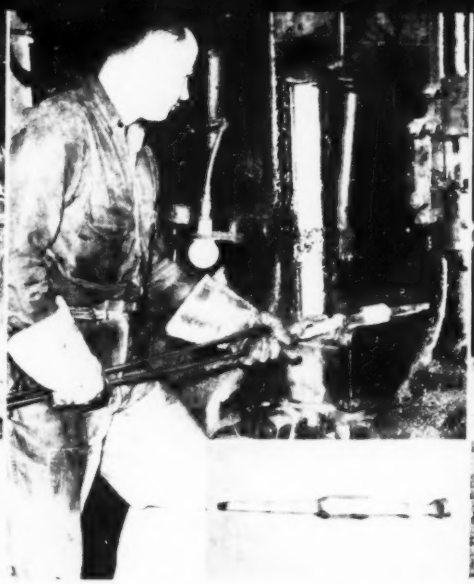
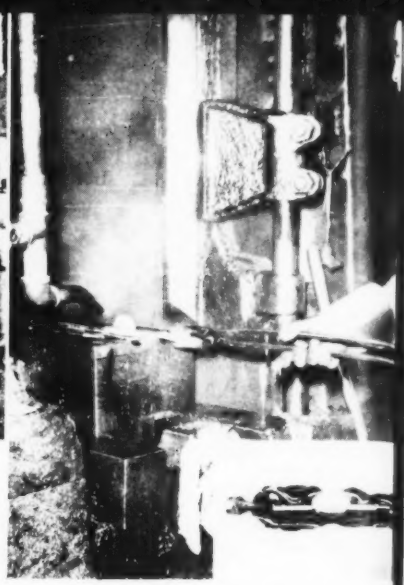
DETROIT



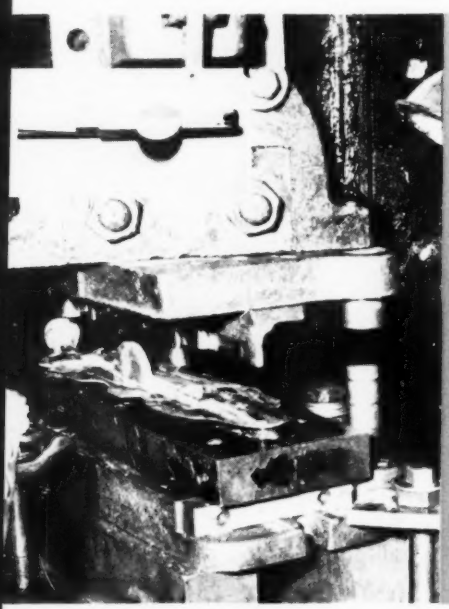
Cutting Bar



Lengthening and Shaping



Shaping to the Die



Trimming the Flash

FORGING ALUMINUM

into

Pressure Cooker Tops

Finishing and Polishing

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74th Street and Ashland Avenue — Chicago 36, Illinois

FORGINGS IN ALUMINUM — BRASS — BRONZE — COPPER — MAGNESIUM — MONEL — ALLOYS

MACHINING FACILITIES

East Side, West Side, All Around Indianapolis

Main Office of Indiana National Bank, Indianapolis. Equipped when originally designed by D. A. Bohlen & Son with Webster Steam Heating System. In 1947, Strong Brothers, heating contractors, modernized the installation by installing Webster Moderator System.

East Side Branch Office, Indiana National Bank, Indianapolis. Equipped with Webster Heating System. Heating Contractor: Cook Brothers.

West Side Branch Office, Indiana National Bank, Indianapolis. Equipped with Webster Heating System. Heating Contractor: Roland M. Cotton Co., Inc. Consulting Engineer: Ammerman, Davis & Stout.

North Side Branch Office, Indiana National Bank, Indianapolis. Equipped with Webster Heating System. Heating Contractor: Roland M. Cotton Co., Inc.

The Indiana National Bank, successor in 1865 to the business of the Indianapolis branch of the State Bank of Indiana, organized in 1834, has been a Webster customer for over 34 years.

Ever since a Webster Vacuum System was installed in the main office building in 1914, Webster Equipment has been purchased for the main office building and the various branches, keeping the bank properties abreast of the latest developments in comfort and economy in heating.

In 1947, a Webster "Controlled-by-the-Weather" Moderator System with Outdoor Thermostat was installed in the main office building. Prefabricated Webster System Convector Radiation with integral supply valve and thermostatic trap was used.

Webster Systems of Steam Heating are also installed in the three recently constructed branch office buildings of the Indiana National Bank.

In each of the new branch offices, Webster Type WI Extended Surface Radiation with Webster traps and valves was installed. Especially suitable for this type of building which has limited floor space, WI Radiation meant increased useable aisle space.

As was the case in their selection of heating equipment, Indiana National Bank chose the same architectural firm to design all of their buildings.

D. A. Bohlen & Son is said to be the oldest established firm of architects in the United States, servicing Indianapolis clients for the past 80 years.

An important factor in the success of these installations was the close association that has existed between bank management, under President Russell L. White, the Architect and Webster Representative, S. E. Fenstermaker.

The story of Webster heating in Indiana National Bank illustrates how Webster serves their customers. Let us help you with your heating.

Address Dept. TR-4

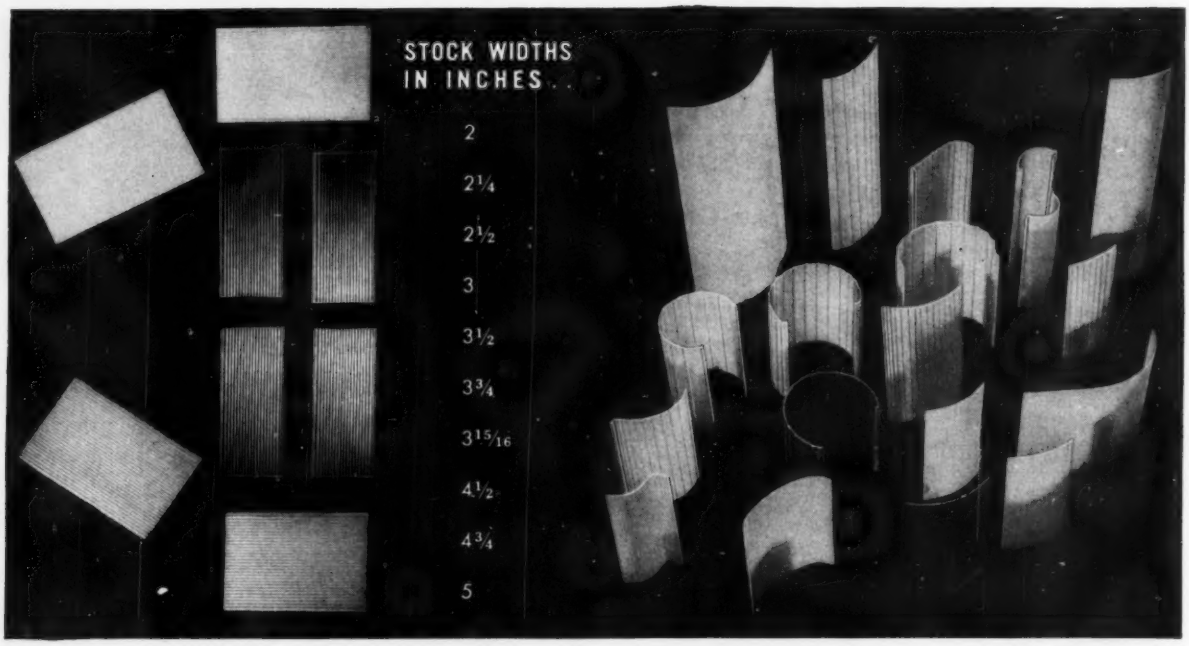
WARREN WEBSTER & CO.
Camden, N. J. : : Representatives In Principal Cities
In Canada, Darling Brothers, Limited, Montreal

Webster HEATING

THE TECHNOLOGY REVIEW, April, 1949. Newsstand Edition. Vol. LI, No. 6. Published monthly from November to July inclusive at 8 Harmony Place, Brattleboro, Vt. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Brattleboro, Vt., under the Act of March 3, 1879.

HOW TO *IMPROVE* FLUORESCENT LIGHTING FIXTURES

and Cut Costs, too!



STOCK SIDE PANEL SECTIONS

SANDEE has developed *plastic* side and bottom panels for Fluorescent Lighting Fixtures to a high degree of efficiency! They are now available in clear or translucent materials for quick shipment in both STOCK and CUSTOM sections. Sizes range up to 15 inches in width. All sections supplied cut to length to fit your fixture. They may be used for side or bottom panels in single or *double* widths.

"POLY-LITE" Extruded Panels offer many superior advantages. Electrical Contractors, Electricians and Maintenance men . . *all welcome* Fluorescent Fixtures "POLY-LITE" equipped. They

CUSTOM SIDE PANEL SECTIONS

are 1. easier to install; 2. lighter in weight; 3. *safer* . . much less breakage; 4. easier to clean . . just wipe with a cloth dampened with a detergent.

Other advantages include controlled *uniform* light transmission, very excellent rigidity, remarkable dimensional stability (resistance to distortion), and unsurpassed design possibilities. Take advantage of Sandee's *practical* know-how of materials, designing for extrusion and unique production techniques. Ask our extrusion engineers for suggestions, ideas, samples and cost estimates. There's no obligation.

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"WORLD'S LARGEST CUSTOM EXTRUDERS OF PLASTICS"

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EXTRUDED POLYSTYRENE SIDE SHIELDS BY SANDEE

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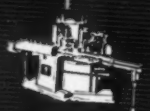
GRINDING MACHINES

REFRACTORIES

NORBIDE

NON-SLIP FLOORS



LABELING MACHINES

ABRASIVE PAPER AND CLOTH · · · SHARPENING STONES

Another NORTON "FIRST"

THIS time it's a *ceramic* surface plate—an entirely new type of plate for toolmakers and inspectors to use in making their precise measurements. This Norton-developed ceramic plate has distinct advantages over previous types of surface plates including: (1) a longer-lived surface, (2) a smoother surface, (3) a flatter surface and one that *stays* flat. It's a plate that will not warp or deform, will not sweat or corrode, will not deflect under load.

The development of this unique surface plate is typical of the progressive research that has made Norton an acknowledged leader—nor only in abrasives and grinding wheels but also in the development of grinding and lapping machines, high temperature refractories and a wide variety of wear-resistant materials.

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The main Worcester plant of Norton Company—world's largest producer of abrasive products

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from London to Cardon...

for Shell's Cardon Refinery Venezuela

...now being built by Lummus

A Shell Photograph

A Shell Photograph

Typical of the scope of Lummus foreign operations is the construction of a refinery at Cardon, Venezuela, by The Lummus Company of New York and Compania Anonima Venezolana Lummus for The Shell Oil Company of Venezuela. Most of the fractionating equipment, like the hundred-ton tower illustrated, was fabricated in England and Holland, and transported to Venezuela. Staffed offices in London and Paris give Lummus an added flexibility in operation and the advantages of wide purchasing contracts.

In oil producing states in America, all through Europe, in the Near East, Netherlands Indies, South America, China—Lummus has built more than 150 gasoline refineries, upwards of 90 process units for solvent refining and dewaxing of lube oils and more than 300 chemical units, including complete plants of ethylene, butadiene, styrene, phenol.

THE LUMMUS COMPANY
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which will not cause black rubber to stain adjacent materials, is essential in many phases of the rubber industry. Cabot has the right carbon black for carcasses of white side wall tires, for automobile window channels, refrigerator door strips and many other applications which require a non-staining black pigment.

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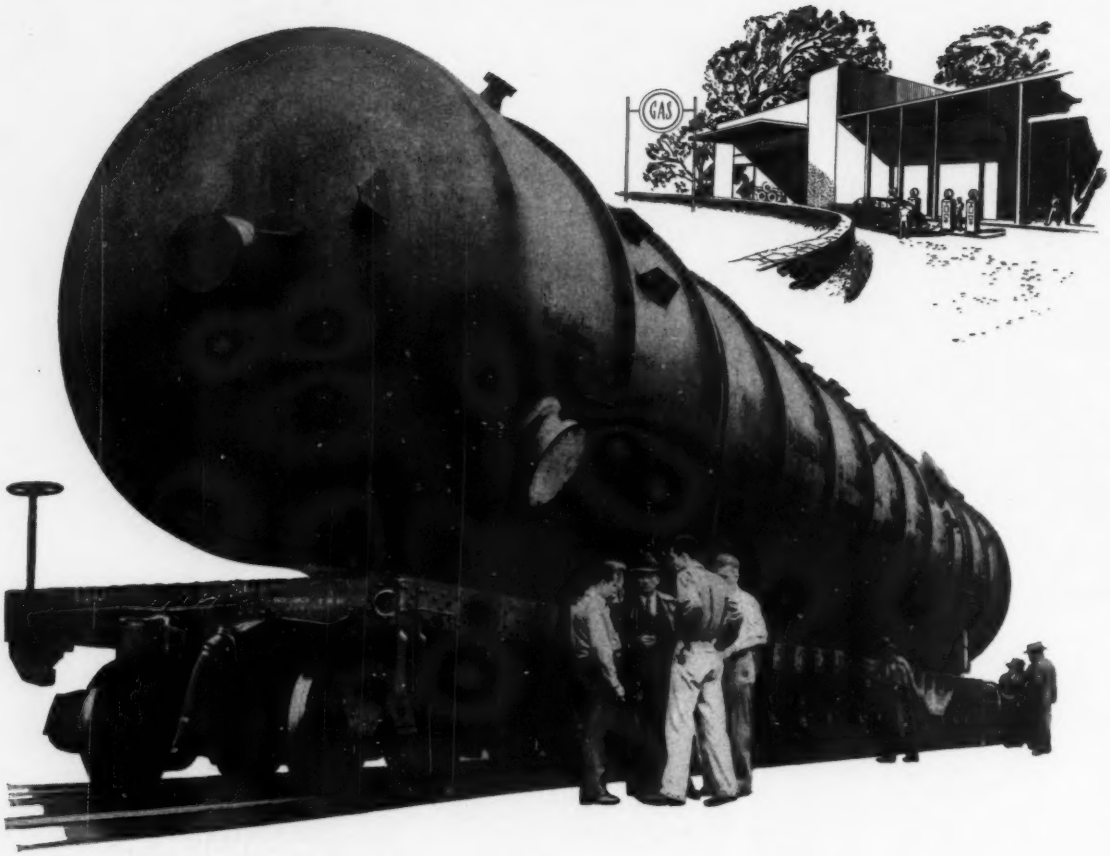

Metal Monsters

—that let you say, "Fill 'er up"

When you stop at a service station and say, "Fill 'er up", it's quite possible that your gasoline has been processed through huge C-E pressure vessels like the bubble tower shown above. This giant tower, built in the St. Louis shops of Combustion Engineering-Superheater, is 92 feet high, over 13 feet in diameter, and weighs 490,000 pounds.

This "metal monster" is by no means unique. Combustion has built hundreds of big pressure vessels, many for the largest and most modern oil refineries, and many more of various shapes, sizes and metal composition for plants in the chemical and other process industries.

Combustion's contribution to the gas that flows into the tank of your car may seem to bear little relationship to its major field of steam generation, yet the association is direct and logical. For the facilities required to build boilers are identical to those used for the fabrication of pressure vessels—and the Company's facilities for boiler manufacture are the finest available.

Whether the product is pressure vessels or boilers, industrial stokers or domestic water heaters—in many seemingly diverse fields, you will find the C-E flame symbolizing Combustion's primary purpose — the more efficient utilization of heat. B-253

C-E

COMBUSTION ENGINEERING—SUPERHEATER, Inc.

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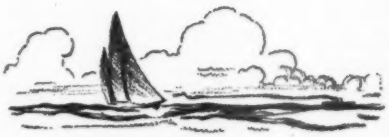
All types of Boilers • Furnaces Pulverized Fuel Systems • Stokers Superheaters • Economizers • Air Heaters. Also, Pressure Vessels Chemical Recovery Equipment • Flash Drying Systems • Sewage Incineration Equipment • Domestic Water Heaters.

In the days when cattlemen drove their stock across the unfenced prairie to the railhead, it was common practice among the least scrupulous to feed the cattle plenty of salt before they were offered for sale. When they were allowed to drink their fill, the gain in weight was the buyer's loss. Hence the term "watered stock" sensationalized in early days of corporation revelations and regulations.

Print from Bettman Archive

Are you selling "WATERED STOCK?"



WATER is just about our commonest material. In many places it is indispensable; in some places it is beautiful; but in others it contributes nothing but extra weight and the risk of depreciation. To send a six-ounce orange North from Florida freight must be paid on over five ounces of water which the North has in abundance — and then it must be eaten quickly before it rots.

BLOOD PLASMA

When World War II darkened the horizon Army doctors looked beyond the outright slaughter to the millions of wounded who might die in the field. Blood transfusion could save many but in a remote, devastated theater of war it was unthinkable — unless blood collected from a healthy population could be reduced, preserved, transported and reconstituted. To make this possible National Research Corporation took low temperature, high vacuum dehydration from the laboratory and developed it to the level of mass production.

PENICILLIN

Faced with an urgent wartime need for a universal antiseptic the English recalled the experience of Alexander Fleming with the blue-green mold, Penicillium Notatum. Under pressure the wonder antibiotic was accumulated — enough for a mouse, enough for a man, enough for twenty men — and then, grown by "kitchen culture" in millions of milk bottles, enough for an army. Again there was need for dehydration without heat damage and National Research's high vacuum process now installed in substantially all of the larger plants throughout the world, turned penicillin into powder at a rate to supply the world.

ORANGE JUICE

During the war we experimented with the dehydration of many common foods; meat, fish, vegetables, fruits, coffee. Of these orange juice was the most promising with a nationwide market ready and a world market waiting. We had produced citrus concentrate and powder on a pilot plant scale. Near the war's end we organized Vacuum Foods Corporation. For them we built and equipped a plant in Florida that now concentrates, for the national market, 75,000 gallons of juice a day.

This new industry, producing some 4½ million cans in the 1946–47 season is expected to reach an annual production rate of 200 million in 1949. Within five years it is predicted that one-fourth of all Florida's oranges will reach their market as concentrated juice. In this industry Vacuum Foods is the pioneer and leader.

COFFEE

The success story of orange juice will, we hope, be rewritten for coffee. For over a year we have been producing in small quantity a "crystalline coffee" — pure coffee essence, nothing more and *nothing less*. This small production is being market-tested through the local retail trade and a steadily increasing number of users have found out that coffee *can* be reduced to an instantly soluble concentrate, and still taste like good coffee.

WHAT NEXT

To anyone who is selling "watered stock," not with guile but from necessity, National Research can offer a new prospect — lower cost methods of producing dry materials with instantaneously soluble structure. To apply our proven techniques of high vacuum dehydration National Research Corporation stands ready with a carefully chosen, experienced staff, with the newest equipment and with an accumulated knowledge of large scale low temperature dehydration that cannot be equalled anywhere.

INDUSTRIAL RESEARCH PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING & EQUIPMENT
Metallurgy — Dehydration — Distillation — Coating — Applied Physics

NATIONAL RESEARCH CORPORATION

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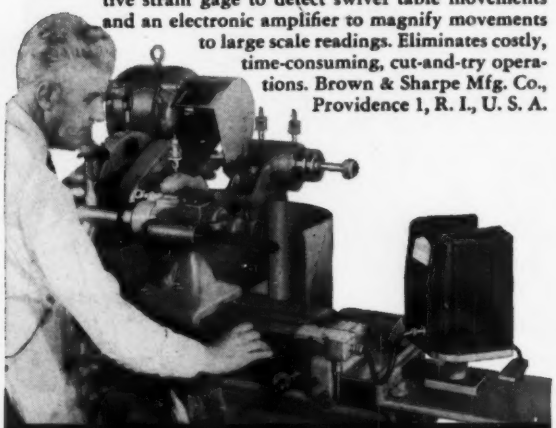
For the first time!... **ELECTRONIC ALIGNMENT OF SWIVEL TABLES ON GRINDING MACHINES**

ELECTRALIGN, an exclusive new Brown & Sharpe development for their grinding machines, permits accurate alignment of swivel table for straight or tapered work after *only one preliminary grind.*

This unique size-control aid uses a highly-sensitive strain gage to detect swivel table movements and an electronic amplifier to magnify movements to large scale readings. Eliminates costly, time-consuming, cut-and-try operations. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.



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Progressive industry demands ever-increasing accuracy in gear production. DIEFENDORF keeps pace with these demands of progress. All type gears cut to specification. Standard production. Emergency aid. Design service. All metals and non-metallics.

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DIEFENDORF GEARS

THE TABULAR VIEW

NO SALESMAN harasses those who patronize coin-operated vending machines, but this is a minor aspect of the growing business of selling by machines. As editorial associate of The Review and keen analyst of the social phases of scientific and technological change, PAUL COHEN, '35, traces the growth of mechanized selling (page 327) from its early beginnings in the penny arcades of the 1880's to today's supermarkets which are almost entirely automatic. It was during the 1930's that the various forms of slot machines outgrew their carnival attire and became a truly significant force in our social structure. Revealing his engineering training, Mr. Cohen attributes the recent rise in mechanized selling to such technological factors as mass production, carefully regulated coinage, standardized packaging, and the availability of highly reliable electromechanical assemblies. If mechanized selling has an important social effect in reducing costs of distribution, it has even greater significance in freeing persons from routine operations and making them available for tasks requiring creative talent which cannot be mechanized.

NO SURGEON of the Renaissance would be entirely at ease in a hospital of today with its array of modern equipment. Yet the mental attitude of today's medical men would be stranger than their physical equipment, for all but a few Renaissance workers were steeped in medieval thinking. The transition from medieval to modern medicine is traced (page 331) by DR. M. F. ASHLEY MONTAGU, a member of the faculty of the Hahnemann Medical College and Hospital of Philadelphia, and already well known to Review readers for his articles on varied topics in the field of cultural history. His present article points out how the inquiring spirit which led to the rise of the physical sciences had an equally important bearing in developing the era of modern medical science.

NO SCIENTIST has yet offered a completely satisfactory explanation of the origin of the green glasslike obsidian found in various parts of the world. The difficulties of finding a satisfactory explanation for its origin are somewhat akin to those of accounting for the properties of "the ether" or in choosing between the wave and the particle nature of light. First discovered in Bohemia, the green shards were alternately regarded as natural and artificial, and occasionally as both and neither! The fascinating chronicle is told (page 335) by WILLY LEY, editorial associate of The Review for several years and frequent writer on scientific subjects. Mr. Ley alternates his periods of writing with research. Having completed certain research at the Washington Institute of Technology, he has once more turned to writing as his primary vocation. To his credit are volumes entitled: *Rockets; The Days of Creation; Bombs and Bombing; Shells and Shooting;* and *The Lungfish, the Dodo, and the Unicorn.*

"—They perfect nature and are perfected by experience"—FRANCIS BACON

What these man-made gems mean to you

SYNTHETIC STAR SAPPHIRES like this one, which only the finest of nature's stones can equal, are now made by *man.*

Yes, Union Carbide—which since 1942 has made synthetic crystals for precision instruments and other industrial uses—today produces the loveliest of synthetic star sapphires *and* rubies for personal wear.

But far more important to all of us are the research and technical skills . . . the work with extremes of heat and cold, with vacuums and tremendous pressures . . . that lie behind these superb jewels. The research and skills that produce today's *better materials* . . . used by industry in turning out numberless products.

The same research that brings these man-made stars within our reach . . . brings us, too, man-made leather and rubber. It also gives us today's *better* food, clothing, and shelter. It helps us resist disease. It improves our heating and lighting. It's a part of our swifter, safer transportation systems . . . our communications . . . our progress in construction.

The people of Union Carbide work with a vast range of Alloys, Chemicals, Carbons, Gases, and Plastics. They are constantly perfecting new processes . . . and producing hundreds of materials . . . for the use of science and industry to benefit mankind.

FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which shows how science and industry use UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

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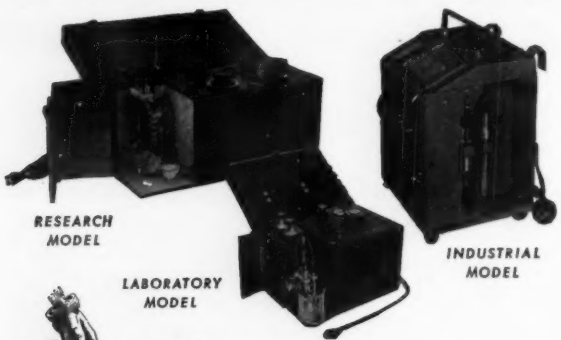


pH METERS

line-operated — accurate!

The three models illustrated above incorporate many new and important advantages. All are AC line-operated . . . no battery nuisance. Laboratory and Research models use electron-ray tube for precise null-point indication. Industrial model is a direct-reading instrument, ruggedly built for plant use.

Accuracy: Research .02 pH, Laboratory .05 pH, Industrial .10 pH. Other line-operated Cambridge pH equipment includes single- and multi-point indicators and recorders. Send for bulletin 910-MR.

CAMBRIDGE INSTRUMENT COMPANY, INC.

3707 Grand Central Terminal, New York 17, N. Y.

Pioneer Manufacturers of

PRECISION INSTRUMENTS

MAIL RETURNS

Aviation Fire Hazards

FROM GEORGE H. TRYON, 3D:

I have read the excellent article "The Price of Haste" by W. Mack Angas and William T. Hardaker in the February, 1949, Review.

Our committee was particularly pleased to note the emphasis placed on the reduction of fire hazards in aircraft since this subject is the motivating force behind our committee activity. We are much in sympathy with the authors' opinion that detection and extinguishing devices are palliatives which reduce the danger without striking at the roots of the problem. The suggestion to expedite research and experimentation in the use of oil-burning Diesel aviation engines and turbines was particularly interesting to us.

There are many other features of the aviation fire problem which might have been mentioned in the article if space had permitted. The crash impact fire hazard is particularly severe, and we are convinced that loss of life in such accidents is primarily due to ensuing fire, rather than impact, in many cases where the impact forces are not of the highest severity. Our recommendations for aircraft rescue and fire-fighting equipment for airports reflect the magnitude of this hazard, and yet we are supremely aware of the fact that this equipment and its urgent need will do nothing to reduce the number of such incidents because the hazard is not being corrected by their provision.

Committee on Aviation and Airport Fire Protection
Boston 10, Mass.

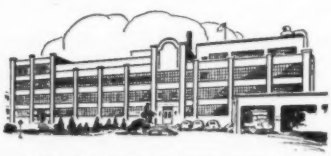
Contributions to Peace

FROM ALAN F. LYDIARD:

I was very much impressed with Donald J. Eberly's article "International Relations" in the November, 1948, Review. The National Student Association Committee and M.I.T. should be congratulated on their splendid contribution to universal peace.

Boston, Mass.

Speed with Economy



Fairchild Camera and Instrument Corp.

Before you engage a builder, look into the character of his personnel. Our 6 key executives have been working together for many years. Our foremen have a comparable record of long training with the Company. This results in an efficient and cooperative organization—your assurance of speed, quality and reasonable cost.

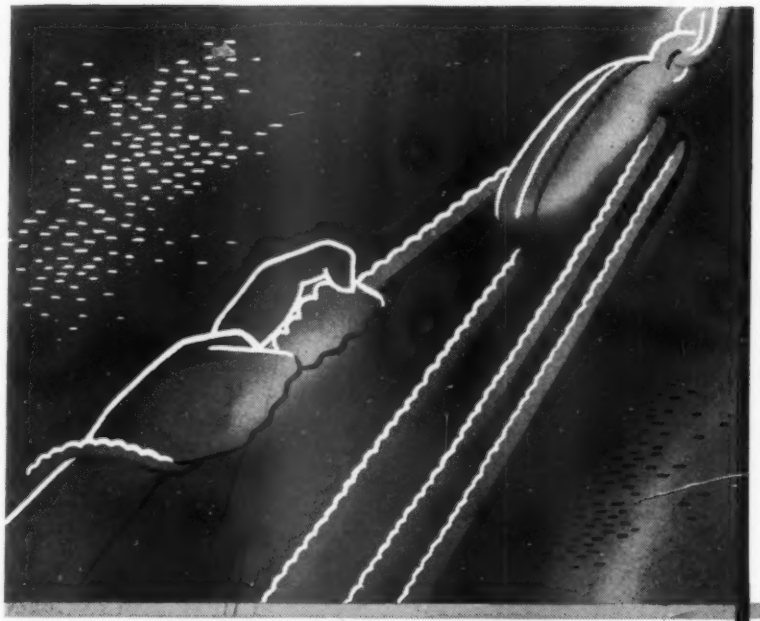
W. J. BARNEY CORPORATION

FOUNDED 1917

101 PARK AVENUE, NEW YORK

INDUSTRIAL CONSTRUCTION

ALFRED T. GLASSETT, '20, *Vice President*



When sail trimming is required

No business can stay healthy without an occasional overhaul of its production set-up—particularly when a seller's market begins to quiver.

Molybdenum steels may be just what the doctor ordered to reduce production costs, and still maintain the product's reputation for consistent performance.

Send for our comprehensive 400-page book, free; "MOLYBDENUM: STEELS, IRONS, ALLOYS."

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

C4

He's got the answers to your tire questions!

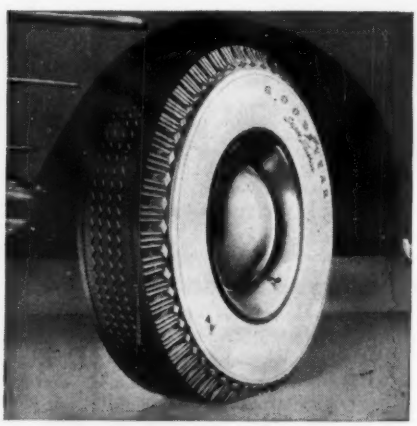
RIGHT from the start, you notice that Super-Cushions give you a much softer, more comfortable ride.

But you naturally want to know what kind of mileage they're going to give you, too. And Mr. R. W. Rogers, head of the Rogers Construction Co., in Portland, Ore., can tell you:

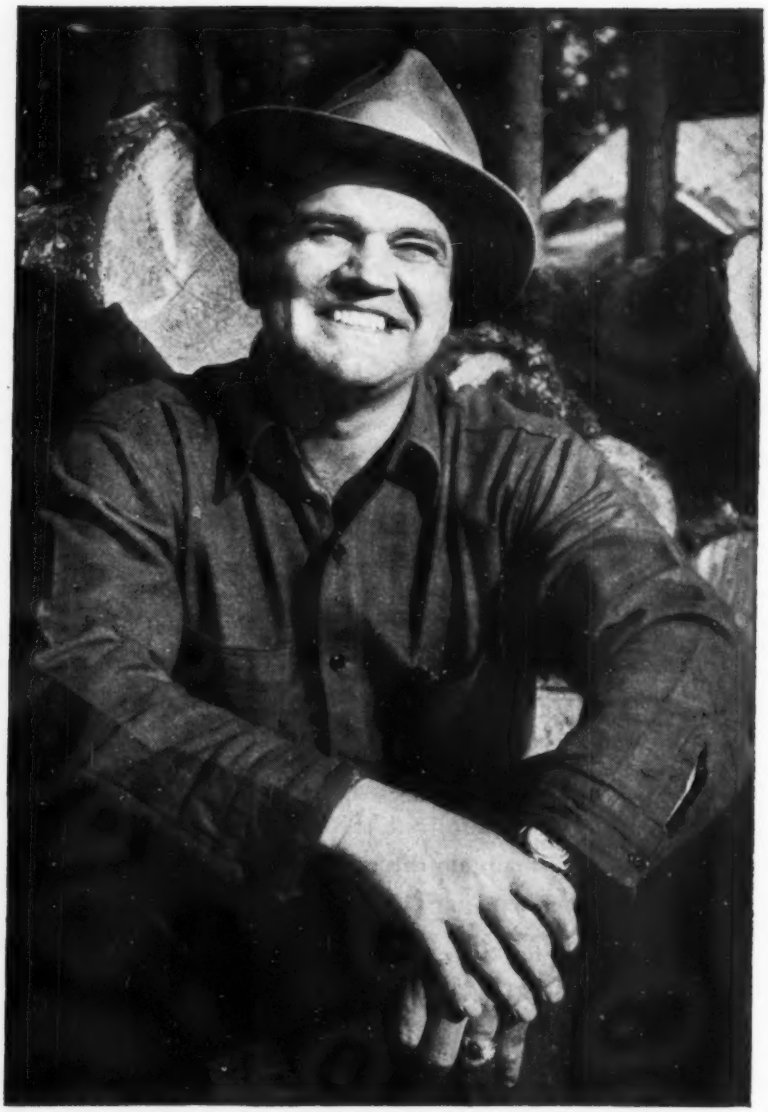
Mr. Rogers says: "Over a period of years, I've used nearly every tire on the market—and I find that Super-Cushions are giving me more mileage than any other kind.

"It's amazing how much smoother they make your car ride, and how much better traction you get."

Softer ride! Super-Cushion is bigger and softer. *It runs on less air pressure.* It absorbs road shock, jars and vibration. So you get a pillowy ride, less car wear, and fewer rattles!



Greater Safety! Super-Cushions have a larger contact area with the road. So you get better traction, quicker stops. They'll fit your present rims. See your Goodyear dealer *now!*



Super Cushion by GOODYEAR

MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER KIND!

Super-Cushion T. M.—The Goodyear Tire & Rubber Company

Fritz W. Neugass

Washington Bridge

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS *for April, 1949*

VOL. 51 No. 6

AGE OF STEAM · *Photograph by Victor De Palma from Black Star* THE COVER

APRIL SHOWERS · *Photograph by Gustav Anderson from A. Devaney, Inc.* ..... FRONTISPIECE 322

MECHANIZED SELLING ..... BY PAUL COHEN 327

The engineer's ingenuity makes substantial contributions to reduction of distribution costs through the expanding use of coin-operated vending machines

RENAISSANCE MEDICINE ..... BY M. F. ASHLEY MONTAGU 331

During the Fifteenth and Sixteenth Centuries a few hardy souls led in paving the foundations for the rise of scientific medicine

GLASKOGELS ..... BY WILLY LEY 335

Still unsolved is the mystery of the origin of the pieces of green glasslike stones first found in Bohemia, but subsequently discovered in other parts of the world

THE TABULAR VIEW · *Contributors and Contributions* 316

MAIL RETURNS · *Letters from Review Readers* 318

THE TREND OF AFFAIRS · *News of Science and Engineering* 323

THE INSTITUTE GAZETTE · *Relating to the Massachusetts Institute of Technology* 337

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Gustav Anderson from A. Devaney, Inc.

April Showers

THE
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REVIEW

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The Trend of Affairs

Public Health Agent

In the United States, most diseases amenable to control by sanitation of the environment through engineering measures have declined steadily during the Twentieth Century. One disease in this category, endemic typhus, has moved precisely opposite to the general trend however. Endemic typhus is a febrile disease that is fully as debilitating to the human being as typhoid fever. Also known as murine (or rat-borne) typhus fever, this infection is spread by fleas that normally live on rats, but occasionally bite human beings as well.

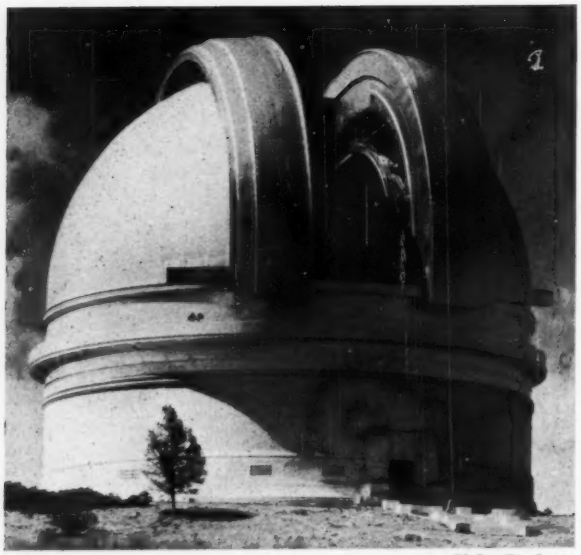
Since 1913, when endemic typhus in this country was first reported in Georgia, recognized cases of the disease have grown steadily more numerous. In fact, during the early 1940's, reported cases increased at the rate of nearly 1,000 each year. Furthermore, known cases are only a partial indication of the true extent of this disease, since intensive local surveys have revealed that many cases go unrecognized, and that endemic typhus actually occurs at least two and a half times more frequently than reported cases indicate.

To date endemic typhus has been confined mainly to the South Atlantic and Gulf Coast states, with more than 67 per cent of the recognized cases occurring in 100 counties in that section of the country. Nevertheless the disease has spread inland slowly, with the result that certain southern cities, beyond the present focus of endemic typhus, are now actively engaged in programs to prevent its encroachment.

The only means at present available for coping with endemic typhus is the obvious one of eliminating the vectors — the rat and the rat flea. Rat control is, of course, a desirable objective for additional reasons as well, since rats convey other diseases, and also cause serious economic loss when they destroy or defile foodstuffs and other valuable materials. The basic method of controlling rats is the elementary and long-established procedure of "building them out," through the construction of buildings with doors, windows, and other openings designed to exclude rats; with foundations built so that the animals cannot enter by burrowing; and with interiors planned to eliminate harborages that serve as hiding and breeding places. Sometimes alterations of existing buildings can render them ratproof. But unfortunately the economic obstacles to universal ratproofing are great. Rat-control programs must often rely upon a secondary and admittedly less effective procedure, that is, periodic attacks upon the existing rat population. Trapping and fumigation were formerly the principal methods for this purpose, but new and potent rodenticides, such as 1080 and ANTU have proved very effective.

A novel and truly extraordinary procedure currently used against endemic typhus is application of the insecticide DDT to kill the fleas on rats without destroying the rats themselves. This procedure is carried out by dusting DDT preparations in rat runs, harborages, entrances, feeding points, and other areas frequented by the pests. Studies conducted by live-trapping rats in buildings thus treated with DDT indicate that flea infestation of the animals may be reduced by this method to 15 per cent or less of its usual level, thereby greatly lessening the danger of endemic typhus transmission.

But antirat and antiflea campaigns have only transient effectiveness. A new population of rats quickly reinvades any cleared building that is not ratproof. Residual flea populations reproduce rapidly, and in time reinfest all of the local rats. Hence the only permanently effective means of eliminating endemic typhus fever, and other dangers from rat infestation, is the engineering measure of ratproofing all buildings. Thus the story of endemic typhus fever offers one cogent demonstration of the fact that the engineer, through his role in providing sanitation of the environment, remains an essential public health agent.



Philip Gendreau

Mission Accomplished

FEW men with prophetic vision, whose lifelong work is destined to have an important bearing on our way of living or thinking, are fortunate enough to see their dreams come to fruition. Still fewer live long enough to be able to witness the full impact of their work as it affects the lives of their fellow men. But prior to his death on February 23, Russell Williams Porter, '96, was one of those fortunate beings who could look back on decades of close association with the 200-inch telescope on Mount Palomar with the satisfaction of one whose work was well done. He did not live to see the huge telescope make any major contributions to knowledge, for several years will elapse before the large telescope will be operating at its full potentialities. But he did live to see the giant mirror dedicated last June, and recently he expressed satisfaction with the operation of the world's largest telescope. "I've seen enough to know the telescope is going to be better than we had thought," he commented, a few weeks before his death.

According to Ira S. Bowen, who heads the Mount Palomar project, the 200-inch telescope is already doing extraordinarily well in preliminary tests. Today, even with many final adjustments still to be made, it is regarded by its makers as a better instrument than the former world's largest telescope. Its promise for the future is exciting indeed, even though it is still necessary to rectify certain minor difficulties which invariably turn up in any complicated mechanism before it performs properly and before its vast potentialities can be tapped.

Already completed is the intricate work of assembling 500 tons of moving machinery, much of which has been built to tolerances previously unheard of in mechanics. A long running-in period is in progress, and the adjustments and design modifications that are inevitable in all pioneer work are clearly understood and already under way. There need be no concern because the huge glass disk has not yet quite attained its permanent figure.

The great Pyrex mirror, which weighs some 15 tons of itself, and more than 35 tons in its supporting cell, required 11 years of grinding and polishing at the California Institute of Technology to transform it from rough glass form to the world's largest astronomical reflecting surface. Considering that nearly four years were lost when the 17-foot disk was on "inactive duty" during World War II, the 11-year period is reduced to but seven years of active grinding and polishing. After work was resumed in 1946, John A. Anderson, who directed the process of disk shaping, would not admit success until he was sure that human hand could do no better. He and his colleagues realized that the instrument they were fashioning must be more perfect than any other telescope mirror ever before built, if the Mount Palomar disk were to work effectively in recording past events in the enormous depths of outer space. The freedom from aberration and astigmatism, coupled with the extreme resolving power required to study objects many millions of light-years away, could come only from the near perfection of the reflecting surface. When at last the parabolizing was completed in the laboratory, in September, 1947, all competent judges who had part in the project agreed that the goal of accuracy was in sight and could ultimately be attained.

It would indeed have been surprising had the mounting of the 200-inch mirror, in its intricate system of 36 supports, been accomplished with perfect ease. But within a year of completion, supports and drive mechanism operated satisfactorily under test. Attention could now be directed to the problem of making the final modifications in the shape of the mirror; to have neglected to make provision for final polishing after mounting could easily have resulted in years of delay.

When the shop work on the mirror had been completed, it was known that the outer edge was slightly higher than it should be by about 20 millionths of an inch. This excess of glass at the rim was intentionally left on since there was the possibility that the figure would be modified in operating position. No one could foretell exactly what the shape of the surface would be under operating conditions, and the excess of glass was on the safe side for taking care of any possibilities. To have perfectly parabolized the mirror in the laboratory would have been to risk the optical engineer's dread enemy. The only remedy for the "turned-down edge" would be to repolish the entire mirror, an operation which would probably take years to accomplish.

The slightly turned-up edge of the mounted mirror can be remedied by local polishing at the observatory in a few months. Final figuring by local polishing will not be risked, however, until every conceivable test has shown that corrections cannot be made in any other way, and until the effects of all possible distortions, however slight, can be studied with the mirror operating satisfactorily in its mount.

Certain minor temperature inequalities, for example, introduce slight distortions for which correction will be made by fans, and many other small modifications are expected to come to light gradually as the tests become more and more severe. The critical feature of the entire project is the precise parabolic figure of the mirrored glass surface. No hasty

action will be taken that might jeopardize the fine surface already attained.

When the Palomar eye is finished and looks out into space to record events billions of light-years away, what may be expected to result from the project which has cost $6,000,000 and has required decades of planning on the part of a sizable staff of scientists?

The greatest contribution to be anticipated from the 200-inch mirror is in the extensions it will make to our understanding of the nature of the universe. In the hands of competent scientists and research workers, who can deny that the large mirror could change human thinking as much as the comparatively puny telescope in the hands of a Galileo or a Kepler changed the thinking of an earlier day.

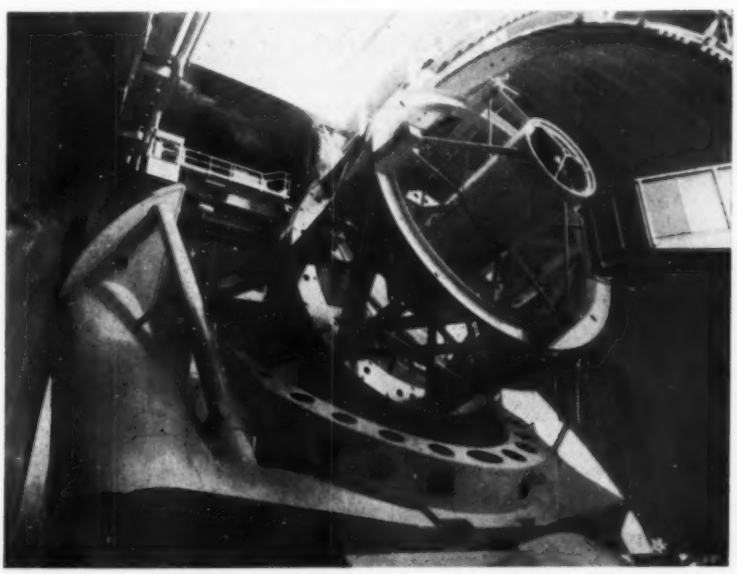
Many men have labored brilliantly and patiently to achieve this great pioneer instrument. Utmost credit is due the scientists, engineers, and artisans who have been associated with the project. Many of these workers, like Dr. Porter himself, have spent a good portion of their lives in bringing the instrument into being. Dr. Porter's mission is finished, but those who are carrying on the work after him can join him in saying: "I've seen enough to know the telescope is going to be better than we had thought."

Chemistry in World War II

World War I, it has been said, was the chemist's war, whereas World War II was the physicist's war. This epigram would appear to be confirmed by the fact that *Chemistry: A History of the Chemistry Components of the National Defense Research Committee 1940–1946*, edited by W. A. Noyes, Jr. (Boston: Atlantic-Little, Brown, 1948), is but one of a series of eight volumes entitled *Science in World War II; Office of Scientific Research and Development*. Nevertheless the tremendous volume and high quality of research, reported in the over 500 pages of fine type in this volume, reveal that chemists and chemical engineers were essential contributors to the prosecution of the second World War. The chemistry activities of the National Defense Research Committee (later integrated into the Office of Scientific Research and Development) began, in fact, in June, 1940, coincident with the organization of the NDRC. Hence the chemical research components of the defense effort were well under way even before the National Guard was called to active duty.

Everyone with a professional interest in chemistry or chemical engineering will want to read *Science in World War II; Chemistry*. The technically specialized reader will find that the reports in this book are well classified into the following seven broad divisions: organization, explosives, chemical warfare agents, aerosols and screening smokes, oxygen problems, weapons for sabotage, and tropical deterioration. Each section presents, with total technical clarity, discoveries made during the six years of operation of the NDRC that in many instances either have been unannounced previously or known only through the often garbled medium of newspaper accounts. Furthermore, as background for elucidating advances, the nine authors who wrote this book frequently provide brief glimpses of chemical fundamentals that constitute a valuable refresher course in the subject. The chemist will also find of interest the complete tabulations of individuals and institutions that directed and carried out various phases of the program.

But even to the nonchemist, this volume is recommended for at least a cursory reading. It is, in no respect, the dry-as-dust research report. Most of it moves along with the flow of a good yarn, sketched against the dramatic background of world events during the immediate prewar and wartime years. Readability is enhanced by mentions of human interest angles of the problems encountered, such as the complications and frustrations regularly experienced by the NDRC chemists as civilians engaged in a crucial



The 200-inch mirror, in its mounting, dwarfs to insignificance the figures at the extreme lower right and in the central tube at the Mount Palomar Observatory. This huge astronomical camera is now nearing its time for use for research purposes, after being in the process of design and construction for decades. Foremost in bringing into being this newest tool for astronomical research were two Technology Alumni: the late George Ellery Hale, '90, entrusted with the construction plans of the project; and the late Russell Williams Porter, '96, affectionately known as "the artist of Palomar" because of his contributions to the architecture of the instrument pictured here.

Acme Photo

phase of the war. For example, strictest cloak-and-dagger secrecy was sometimes maintained concerning the fundamental significance of certain research projects, long after the armament involved was known to, and in use by, the enemy. At times the "uniformed men first" rule left the scientists without transportation to reach important field tests or demonstrations. Or on occasion, when NDRC chemists were housed in Army quarters for the purpose of carrying out field studies, they found themselves deprived of personal necessities, such as towels, because Army regulations provided such items through one procedure for enlisted men and through a different procedure for officers, but made no provision whatsoever for civilians! But then, to be sure, similar frustrations were experienced during the war by members of the armed services as well, and the only wonder is that such maladjustments were not more numerous and more serious in view of the global extent and great exigency of the war activities.

The accelerated tempo of chemical research, supervised by the National Defense Research Committee from 1940 to 1946, yielded a quantity of results that, under normal peacetime conditions, would have taken much longer to produce. Did these findings contribute exclusively to the arts of war? The main subdivisions of this volume, as listed previously, in general indicate that the research concentrated on fields of purely wartime value. However, a careful reading reveals that interspersed is a goodly leaven of results with permanent peacetime value. First of all, knowledge of basic principles was in some respects advanced. A random example in this category is fundamental advances in physiology resulting from studies of the effects of mustard gas upon enzyme systems in the living organism. Secondly, numerous practical discoveries produced by the NDRC program have long-term value. Among these are: antimalarial drugs and other medical agents, rodenticides, insecticides and insect repellents, and an unprecedented understanding of tropical deterioration. It is reassuring to be able to conclude that the staggering investment of money and time reflected in the chemistry components of the National Defense Research Committee program have had at least secondary values in advancing orderly scientific progress. – F.W.N.

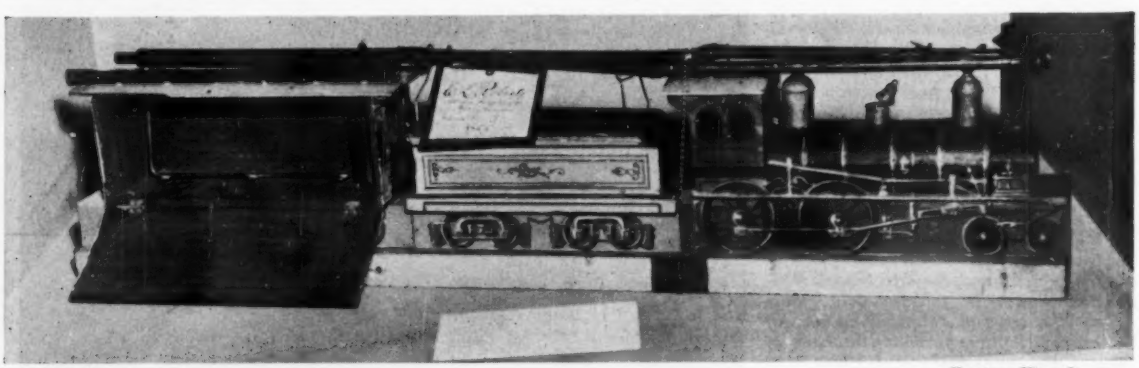
Applied Physics

It is very difficult to appraise the book *Applied Physics: Electronics, Optics, Metallurgy,* as edited by C. G. Suits, G. R. Harrison, and L. Jordan (Boston: Atlantic-Little, Brown, 1948). Its chief function is to serve as a primary source of information for historians interested in analyzing the influence of science on World War II and of the methods employed by scientists in their organizing for the effort. Primarily, it is an administrative history of several divisions of the National Defense Research Committee: 13, 15, 16, 17, and 18. It is obviously a compendium of the writing of various authors collected into a more or less coherent book by the three editors who were also chiefs of the various divisions.

If the purpose of this book is clearly understood, the reader will not be disappointed to find the book completely lacking in humor or in any attempt to be entertaining. It is not recommended to the reader who wishes to relax by the fireside and enjoy a few hours of serious reading. Undoubtedly, a great many facts can be learned from the book. On the one hand it is interesting to a person of technical background who himself has taken part in war research. Such a person will learn, for the first time, what many of his friends were doing. He can now reflect how unfortunate were the circumstances which prevented him from finding out these things during the war when such information would have been of real use. For example, as the book points out, high-speed digital counters were developed during the war. They played no part in any military weapon; but were kept so secret that their use by other scientists was made impossible.

The book indirectly gives credit to the top administrative officers of the Office of Scientific Research and Development and National Defense Research Committee in giving each division of their organization the freedom to choose the administrative mechanism best suited for its purpose. One cannot help but be impressed by the multiplicity of people involved in the metallurgical work. In considering the vested interest and the many aspects of the metallurgical art, it is not difficult to see how such an organization was essential. On the other hand, the countermeasure

(*Continued on page 342*)



Keystone View Company

Shown here is a model illustrating an early attempt to heat railroad cars from the exhaust of the engine's smokestack. The heat-conducting pipes had flexible joints at the end of each car. This innovation of the early post-Civil War period must have left something to be desired in efficient utilization of heat!

Mechanized Selling
AIMS TO LOWER DISTRIBUTION COSTS

Outgrowth of the Penny Arcade,

Today's Automatic Marketing Centers

Are a Direct Result of Engineering Ingenuity

By **PAUL COHEN**

GENERALLY, it costs more to get an article from the factory into the hands of the ultimate consumer than it does to manufacture it. On the average, approximately 60 per cent of the price that is paid to the retailer goes to cover the expenses of distribution. In our efficiency planned, mechanized economy, perhaps odder still is the stubbornness with which the field of distribution has resisted the blandishments of technology until quite lately. In the last 80 years, the physical production of the factory worker has more than tripled, but the individual output per unit of time has changed virtually not at all in distribution. This indifference to technical progress, or at least to mechanization, has been illustrated in quite a striking way. In a report, recently prepared by the presumably unbiased International Labor Office, labor productivity in the United States is compared with that in Great Britain. This country is generally regarded as being more advanced in production equipment and technique than Great Britain. In such fields as manufacturing, transportation, and mining, American output per man exceeds British by from 215 per cent to more than 400 per cent. In distribution, however, the corresponding figure is only 150 per cent.

In spite of slow progress in the past there are indications that changes in methods of distribution are now being developed rather rapidly. One important, and still unchecked, trend toward lower distribution costs – self-service – started with the rise of supermarkets during the great depression of the 1930's. In an earlier era the innovation of the department store and the mail-order house also made significant contributions toward getting products into the consumer's hands economically. In novelty, and in their effect on the field, both of these Nineteenth-Century innovations had many of the earmarks of inventions. But both were more nearly the result of social evolution than of technical developments. On the other hand, the success of the self-service store and the supermarket was based on trends that can ultimately be traced to strictly technical advances. The immediate factors that aided the cafeteria form of retailing were such things as the greater mobility of urban and rural populations, the rise of the domestic refrigerator (permitting the purchase of perishable foods in greater quantities) and, no doubt, the rise of private automotive transportation, coupled with the shortening of the work week, so that time became available for a family expedition to a distant store.

In contrast to that of the self-service store, the success of the vending machine – and it is an exceptionally successful machine – is much more specifically an engineering achievement. Here the clerk is replaced not by the customer, as in a self-service store, but by an automaton – a machine.

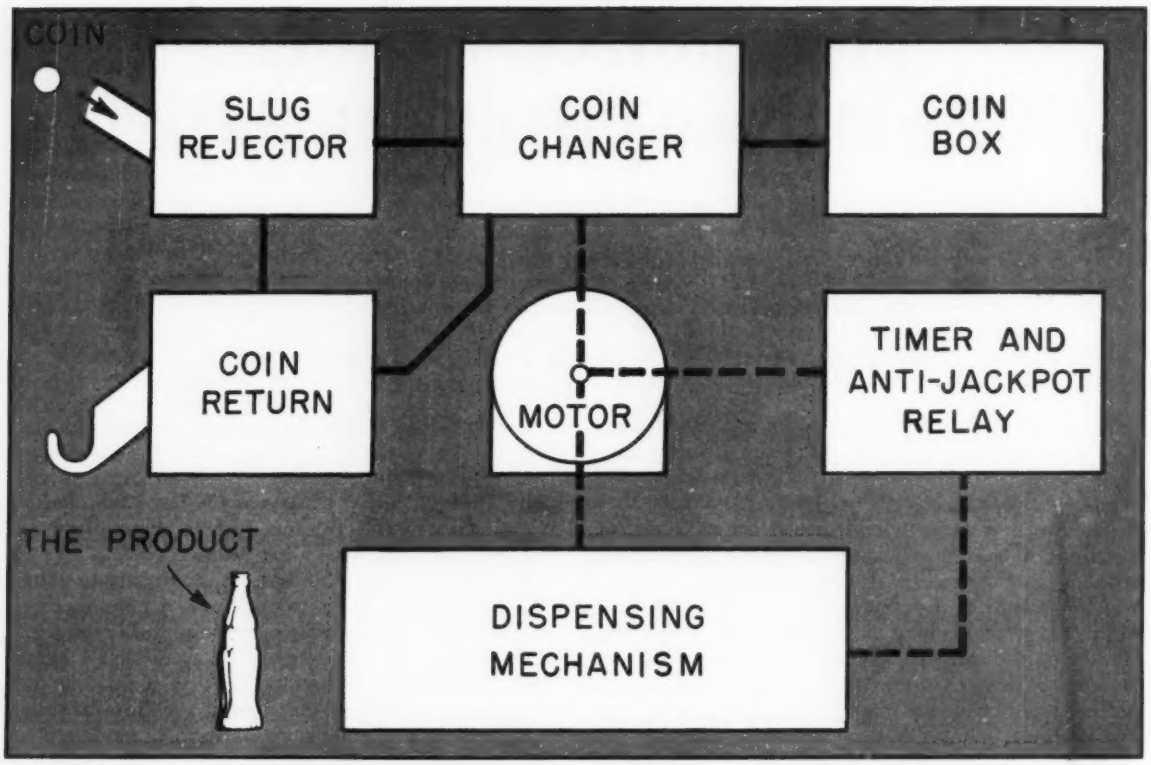
Possibly at least half our population (more than 75,000,000 people), use some form of coin-operated device every week. Gross sales through vending machines were estimated to be about $750,000,000 in 1948, and there are predictions that such sales will total about $3,000,000,000 annually within 10 years.

Like the supermarkets, vending machines date from the depression of the 1930's, for economic evolution, like its biological counterpart, appears to be accelerated by adversity. Although coin-operated games and even vending devices became an adornment of the penny arcades in the 1880's, more than half a century ago, not until the 1930's did they emerge as a significant outlet for consumer goods and services. The juke

Coin-Operated Vending Machines in Use

Type	*Estimated Number in Use in 1948**
Venders of peanuts and other bulk products	1,500,000
Bottle soft-drink dispensers	385,000
Juke boxes	275,000
Cigarette dispensers	250,000
Candy-bar machines	230,000
Scales	200,000
Postage-stamp venders	150,000
Gum machines	100,000
Coin-operated radio receivers	75,000
Coin-operated washing machines	70,000
Popcorn dispensers	45,000
Dispensers of soft drinks in cups	22,000
Milk-dispensing machines	15,000
Cooky-vending machines	12,000
Ice cream-vending machines	3,500
Shoeshine machines	3,000
Cigar-selling machines	3,000
Machines selling apples	2,500
Aspirin dispensers	1,000
Fruit juice dispensers	500
Coffee dispensers	500

* Although these figures are compiled from sources believed to be reliable and well informed, the numbers given should be regarded as indicative, rather than precise.



Block diagram of typical coin-operated vending machine illustrating the relationship of functional units. The heavy solid lines represent the path which the coins take; the heavy dotted lines in the diagram indicate those units which are ordinarily actuated by motive power devices.

box, now so omnipresent that our less kindly critics point to it as a symbol of American culture, did not exist prior to 1933. Today we have in use at least 275,000 (some say 400,000) of these coin-operated, colorful and gaudy marvels. In the United States at the present time there are 1,000 aspirin venders; 1,500,000 venders of peanuts and similar bulk products; 250,000 cigarette machines; 3,000 cigar machines; 230,000 dispensers of candy bars. A full listing would be monotonous but the current situation may be summarized as follows: As of the end of 1948 there were about 623,000 coin-operated service machines, such as scales, phonographs, radio sets, washing machines, and shoeshine contrivances in use. There were about 400,000 machines vending solid edibles, from apples to popcorn. Machines dispensing liquids, either bottled or in cups, numbered about 423,000. As previously mentioned, cigarette and cigar dispensers number 253,000, the former being responsible for about 15 per cent (some estimates say 25 per cent) of this country's cigarette sales, whereas about 150,000 postage-stamp machines were in use last year. It is estimated that there is a grand total of more than 3,000,000 coin venders, excluding coin-operated telephones and parcel lockers.*

In an absolute sense, these are only moderately impressive figures when viewed against the background of American productivity. In the United States today there are about 20,000,000 refrigerators, 18,000,000 washing machines, and the overwhelming figure of 40,000,000 automotive vehicles. Nevertheless, the statistical status of the vending machine must be noted, for the importance of a machine – certainly its social and economic effects – can lie as much in its numbers as in its function. As evidence of this statement it is sufficient to recall that it took more than one Ford to create the gasoline era.

Function, nevertheless, is a reason why the vending machine deserves respect somewhat out of proportion to its numbers. The retailing operation is bounded by many more conditions than the usual machine is called upon to face. No matter how elaborate, most machines are merely tools that assist a human operator in his duties, and within their limitations, respond to his judgment and direction. The vending machine is one of an increasing number of devices that must automatically and reliably meet a repetitive but rather complex situation. In its matter-of-fact way, it is part of the modern industrial revolution. The automatic vending machine typifies the rise of automatic control systems, factories almost empty of personnel, servomechanisms of infinite variety, punch-card machines, digital computers, and other automatic mechanisms that, in the words of Professor Norbert Wiener,† are "bound to devalue the human brain at least in its simpler and routine decisions."

Entailing the making of numerous routine decisions every day, one of the fundamental functions of the retailer, is to make sure he gets paid for his product with the correct amount of sound money. In a vending

* These data are based on a private communication from the Coin Machine Institute.

† *Cybernetics*, page 45 (New York: John Wiley and Sons, Inc., 1948), $3.00.

machine that problem is handled by a coin authenticator or a slug rejector. In the early days of machine selling, when a coin machine dispensed nothing more weighty than a penny's worth of peanuts or a chance to play another game "on the house," the occasional acceptance of a slug was not a matter of earth-shaking importance. Today, however, automatic vending machines are being used to retail items of considerable intrinsic value, or to return change from a coin of larger than the required denomination. Under such conditions it does not take a very large percentage of slugs or worthless coins to wipe out any economic justification for the automatic dispenser.

The compact and almost foolproof slug rejectors now used in the trade are standardized items made by only a few manufacturers, although there are currently more than 100 factories producing automatic dispensing machines. These rather complicated subassemblies are incorporated into the design in much the same manner as a relay, switch or electric motor, and the availability of such reliable, mass-produced components has helped mightily in producing machines that are economically and mechanically sound. Precision limit switches that are actuated by a very small force with a movement measured in thousandths of an inch have made a particularly helpful contribution in the development of mechanized selling. One design of coin changer, which is, of course, a much more complicated device than a rejector, contains four relays, one electromagnet, 12 switches, and one motor. Another requires five switches, four relays, four electromagnets, and two solenoids.

In effect, a slug rejector is a scientifically conceived obstacle race to be successfully negotiated only by a sound coin. But before the test can begin, the coin must enter the slot without jamming, and here appears one of the less obvious factors that have permitted the rise of the vending machine. The success of coin-operated mechanisms depends upon a carefully regulated coinage in which each coin is held to rigid specifications, is rapidly manufactured in amounts necessary to satisfy public demand, and is withdrawn from circulation as soon as it is observed to be defaced or badly worn. The extent to which the number of coins in circulation has increased during those years in which machine venders have had their greatest growth, may be gauged by production figures of the Federal Government. In 1932 the Philadelphia mint alone produced 14,500,000 coins, whereas in 1943 it produced more than 303,000,000.

In these days of mechanized selling, the need for uniform currency was irritatingly demonstrated in the epidemic of jammed turnstiles that followed the shifting of the New York subway fare from a nickel to a dime. It was nearly three weeks before bent and defective dimes were weeded out of circulation to a sufficient degree to return turnstile breakdowns to a normal level. But even a coinage which is highly standardized, precisely made, and adequately maintained will not eliminate all difficulties, for "wet coins from the fingers of perspiring riders were jamming some machines, as they always do in midsummer." Conductivity is one of the properties that are generally checked in a coin, but not necessarily in a manner that would be interfered with by a surface film of moisture on the coin.

During New York's momentous shift in fares another sidelight on transit systems and coin machines was furnished when several hundred bus drivers balked at the twin tasks of driving their vehicles through city traffic while selling transfers to patrons at the odd and change-making price of six cents. In contrast to the discord which has so often marked the introduction of labor-saving mechanisms, comparative peace and quiet were reinstated when the Board of Transportation rushed into use about 400 coin-collecting machines and transfer machines.

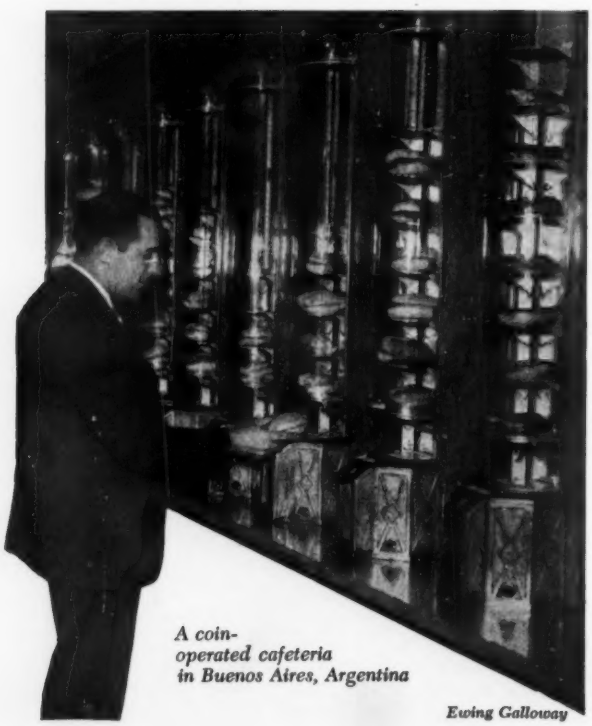
Once a coin is sorted by denomination and fed to the proper circuit, it is checked for thickness, diameter, and weight. It also falls between the poles of a magnet which removes slugs made of iron or steel. In passing through the magnetic field, eddy currents are set up in the nonmagnetic slugs, such as those made of copper and zinc, and the good coins of copper, nickel and silver. These eddy currents slow down the passage of the coin in the machine, and the amount by which the eddy currents decrease the rate of fall of the coin depends on the conductivity of the metal. If the unit is set to accept nickels, the trajectories of the copper or zinc slugs will fall short of a strategically placed anvil. The nickel, striking the anvil, bounces into the "accepted" channel, there to perform its final and ultimate function of tripping the switch that sets the dispensing cycle into operation.

Ewing Galloway

Typical of coin-operated vending machines is this device for selling postage stamps.

Inserting the proper coin in the slot completes his task so far as the customer is concerned, unless the machine has been exhausted of its product. The initiation of the dispensing cycle does not end the problem for the machine's designer however. From California comes the story (horrible to a vending-machine operator) of the ice-vending machine whose duty was to dispense one 25-pound cake of ice after the insertion of two dimes. When one young man prodded this machine with the customary $0.20 he was presented with not one, but 30 pieces of ice in succession. From one of the vending machine's less savory relatives (the slot machine or "one-armed bandit") comes the new verb, to jackpot, describing this phenomenon. Most of the newer vending machines now contain an "anti-jackpot" relay to prevent such occurrences of gratuitous plenty. Used in vending machines, an important variation of the coin testers is the change maker. This device will accept coins of larger denomination than the sales price, and will return the correct change. The ingenious customer is already using them to secure coins for telephone calls and other services. While not yet widely adopted, the change makers will greatly expedite the sale of goods through machines by permitting a wider and easily changed scale of prices.

Just as it depends on a standardized and jealously guarded coinage for its economic existence, the vending machine also requires the standardized packages, goods, and buying habits that characterize the distribution patterns of this country. Such standardized patterns often tend to restrict selection, of course. Nevertheless, the customer still enjoys the illusion of making a free choice. For example, operators have found that a popular brand of product will sell better if placed side-by-side with a number of competing brands, than if it were arranged in dignified isolation.



A coin-operated cafeteria in Buenos Aires, Argentina

Ewing Galloway

Standardized products and containers have been integrated into the design and servicing of vending machines. Although it is conceivable that a vending machine could be built to dispense salt herring from a barrel, and wrap them in yesterday's newspaper, that form of packaging is not conducive to simple and satisfactory performance where sales are machine-made. So universal is satisfactory prepackaging in this country, and so obscured by advertising, that people do not always recognize the engineering features needed to make possible the generally inexpensive containers which enclose the products they purchase. Whether it is a can of soup, a pack of cigarettes, or a box of breakfast food, the package is rigid and capable of guarding the quality of the product for surprisingly lengthy periods. It has to be held to close dimensional tolerances or it could not be handled satisfactorily by automatic packaging machinery in the first place. Free of loose edges that might jam an intricate mechanism, these packages line up neatly in the racks of the vending machines and protect their contents long enough to permit servicing at reasonable intervals. In the reverse direction, the vending machine has already had its influence on the size and price of candy bars, for through such mechanisms about 10 per cent of all such confections are sold. As its numbers increase, the vending machine will undoubtedly influence package design in other fields.

Not the least advantage in expanding the acceptance of the vending machine is the ingrained consumer-buying habit of choosing something familiar. This purchasing characteristic has been developed over many years as the result of national advertising campaigns conducted by firms using the same trademarks and slogans for many years. To the extent that the customer does not have to be persuaded to buy a cup of fruit juice or a package of gum at a certain price each and every time he makes a purchase, the retailing function has become routine. Thus it becomes a natural field for mechanization.

Although the vending machine can dispense almost any item that can be paid for with coins, none has so far been invented that will read paper money. Yet, in spite of this limitation, an obvious extension of machine selling – mechanized stores – is now being studied. The proposed stores could be essentially a collection of vending machines but probably would become a co-ordinated system of coin-operated distributing mechanisms. Trends toward both goals are in evidence. Operators of launderettes are already experimenting with methods for making a more complete utilization, so to speak, of the crowds that gather in those establishments where batteries of coin-actuated, automatic washing machines may be rented by the general public. Already some launderettes are being equipped with vending machines from which ties, hosiery, and coffee can be purchased while the customer's clothes undergo cleansing. One sympathizes with these operators. The sight of a live and healthy customer, whose pocketbook is out-of-reach, must be nerve-wracking.

The whole-hog approach to machine selling, on the other hand, is exemplified most emphatically by the

(Continued on page 355)

Renaissance Medicine

Like the Physical Sciences, Modern Medicine Had Its Origin, about five centuries ago, in the Rise of Experimental Research

By **M. F. ASHLEY MONTAGU**

THE Renaissance is a period which saw the rebirth (and that is what the word "Renaissance" means) of a new spirit of inquiry, not only in medicine, but also in all other contemporary branches of theoretical and practical knowledge. It was not medicine which initiated this new spirit of inquiry, but rather medicine was caught up with other branches of knowledge in the spirit of the time and carried forward by men who had become more or less imbued with that spirit.

What are the qualities which characterize that spirit? In a phrase they may be described as a critical, and often skeptical, attitude toward authority as such, particularly that derived from books, and the development of a free independent spirit of inquiry into things themselves. This spirit is not entirely novel to the Renaissance, for to some extent it is evident in the work of schools and individuals here and there during the Middle Ages (200 to 1400 A.D.). It may be seen in the accomplishments of the Salernitan school of medicine[1] from the Eleventh to the Thirteenth Centuries, and in the writings of such men as Roger Bacon (1214–1294) and Nicolaus of Cusa (1401–1464).

History is largely a matter of ideas in interaction passing through the alembic of men's minds and expressing themselves as acts. The series of events initiating this discussion of Renaissance medicine commences with the attack upon the fortress state of Constantinople in 1451 by Mohammed II, Lord of the Ottoman Empire and the terror of Christendom. At this time, Constantinople was the European repository of almost all that remained of ancient Greek learning. The language of court and church was that of Fifth-Century Athens. In May, 1453, Constantinople fell. The libraries, stored with Greek manuscripts were destroyed, although some of their contents were saved by their custodians who fled with them – mostly to Italy.

In a land rich in merchant princes and humane tyrants anxious to encourage the revival of classical learning with the benison of their support, the arrival of such Greek-reading scholars, laden with their precious wares, was a most fortunate concatenation of events. The appearance of these intellectuals had an enzymatic effect in accelerating the change which had been slowly developing in intellectual Europe. Clerks were busied copying the new manuscripts, and the refugee scholars were occupied in translating and interpreting them. So occupied for the next century, these men were able to spread the light of the classical world and humanize the medieval world by means of the new invention of printing (1444–1454). But, as Sir William Osler[2] put it: "One cannot say that for the first twenty-five years of its existence printing did much, if anything, to free the profession from the shackles of mediaevalism. Not until the revival of Greek studies did men get inspiration from the true masters of science, and for at least two generations they were too busy looking for the fountains to explore for themselves the virtues of their waters. The accurate observation of nature which Aristotle taught, the searching out of her secrets by way of experiment which the Alexandrians and Galen practiced, were the great achievements of the Sixteenth and Seventeenth Centuries, as exemplified in Vesalius and Harvey." However, there can be not the least doubt that the printing of more recent as well as the classical works in medicine, such as those of Hippocrates (1473), Galen (1475), and Celsus (1478) greatly assisted men toward the development of the scientific attitude of mind – that questioning mood which takes nothing for granted until it has been adequately tested and verified.

We may say that the effective, though slow, development of this mood affected medicine during the first half of the Fifteenth Century; an attitude of mind, which was to blossom in the Sixteenth Century, and become systematized in the heroic age of science in the second half of the Seventeenth Century.

To the end of the Fifteenth Century, medicine was still medieval in character – an amalgam of magic, superstition, empiricism, and slavish adherence to authority. The supreme medical authority of the Middle Ages was the Second-Century Greek-Alexandrian physician, Galen of Pergamum (130–200 A.D.). His writings – imitated, abstracted, and commented upon – multiplied into a colossal medical literature. Medical teaching consisted largely in the reading by the lecturer to the assembled students, of Galenical texts and commentaries upon them. Galen dealt with practically every branch of medicine, and a contemporary study of his works would leave little doubt, in the mind of anyone who undertook it, of the greatness of Galen as an original mind, as a biologist, and as a systematizer. It was no fault of Galen's that the Middle Ages slavishly followed him rather than improved upon his example. Deviation from the teaching of Galen was considered a heresy, and so it came about that throughout the Middle Ages, and certainly

Singer and Rabin: A Prelude to Modern Science

The frontispiece of Johannes de Ketham's Fasciculo di medicina, *published in Venice during 1943, provides an insight into the teaching of medicine at Padua University during the Fifteenth Century. Surrounded by Greek and Arabian classics on medicine, from which his discourses are derived, the lecturer in his chair addresses medical students. Patients seeking treatment are shown in the foreground.*

throughout the Fifteenth Century, what the medical student received was based largely on what Galen had written during the Second Century A.D. The student never dissected a body. Dissection was done by a demonstrator who followed the directions as delivered by the lector from his elevated pulpit or cathedra. The most popular text in anatomy was that of Mondino de Luzzi (c. 1275–1326) or Mundinus. His *Anathomia* was written in 1316, and was the first of the practical anatomies. After circulating in manuscript version for 162 years it was eventually published at Padua in 1478. The restorer of anatomy, as Mondino was commonly called, drew his information almost entirely from Galen, Theophilus, and the Arabic authorities. His physiology was almost entirely Galenic. Anatomy and physiology, it may be recalled, were taught as one subject up to the middle of the Nineteenth Century. Up to the middle of the Sixteenth Century knowledge of the structure and functions of the human body was extremely crude. A large number of fairly obvious structures were not known at all, while many organs were described from the dissection of such animals as monkeys, pigs, and sheep.

Surgery was taught principally from the *Chirurgia Magna* of Guy de Chauliac (c. 1300–1368) which was written in 1363. This, too, was a compilation based on the work of some 88 authorities. It was first printed at Lyon in 1478. The work consists of seven tractates. The first treatise consists of an introduction to anatomy. This is followed by a discussion of the treatment of carbuncles, abscesses, tumors, and cancer. Bubonic plague is attributed to the Jews, who according to Guy, wish to poison the world, and also to certain conjunctions of the planets. The contagious nature of the disease is recognized, and venesection, purification of the air, and good diet are recommended. The various kinds of wounds are then discussed, and the methods of treating and suturing them. Ulcers are next treated, and a discussion of fractures and dislocations follows in which de Chauliac advises the treatment of fractured limbs by suspension in a cradle, and fractures of the thigh with splints, pulleys and weights. The sixth tractate deals with local pathology from the surgical point of view, with chapters on such diseases as leprosy, sciatica, the special sense organs. The seventh and final tractate supplies a very comprehensive antidotary of some 750 different substances. It is of interest that in this work Guy deals with anesthesia. He writes: "Some people, like Theodoric, speak of sleep-producing drugs, so that the incision is not felt, such as opium, belladonna juice, hyoscyamus, mandragora, tree-ivy, hemlock, and lettuce; they soak a new sponge in these juices, and let it dry in the sun. And when they have need of it, they put this sponge into hot water, and give it to a patient to smell until he falls asleep. When he is asleep they operate, and afterwards with another sponge soaked in vinegar held to his nose, they awaken him." Such anesthetic procedures were in use throughout the Middle Ages down to the end of the Fifteenth Century, whereafter, for some unknown reason, they seem to have disappeared from practical surgery.[3]

As the standard treatise on the subject, the *Chirurgia* fixed and retarded the teaching and practice of surgery for 200 years. The general level of internal medicine during this period was below that of surgery, and inferior to that of Greece and Rome. Indeed, much that the Greeks and Romans already knew had been forgotten during the Middle Ages. Galenism and the Hipprocratic humoral theory reigned supreme.

According to the humoral theory there are four cardinal humors which constitute the fundamental elements of life and of the living creature: the first is the blood, which issues from the liver, and represents heat; the second is the phlegm, which comes from the brain, and represents cold; the third, the yellow bile or choler, represents dryness and comes from the gall bladder; the fourth is the black bile, or melancholy, which comes from the spleen and stomach and represents wetness.

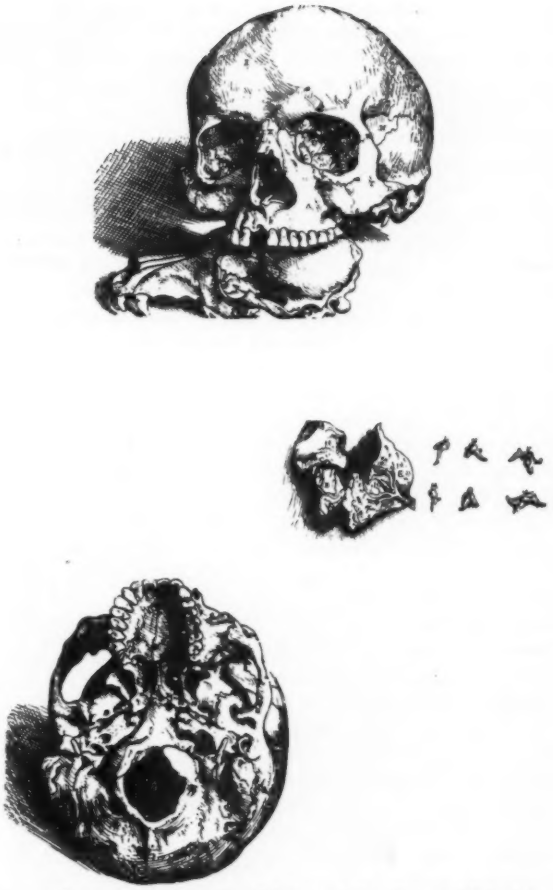
When these humors are harmonically mingled (crasis), the body is in a state of health; when there is a defect or irregularity in the mixture (dyscrasia), disease arises. In constitutional normal excess the "complexio" or temperament of the person was held to correspond to one of four types: the sanguine, the phlegmatic, the choleric, and the melancholic.[4]

The color density, odor, and form of the blood, of the sputum, and above all the urine, gave the Fifteenth-Century physician all the information he needed to make a diagnosis. Bloodletting or cupping, and uroscopy therefore flourished. The urine, as seen in the collecting vessel, was divided into four layers, each corresponding to a region of the body: thus the upper layer corresponded to the region of the head; the lower, to the urogenital organs. Bloodletting reached a fine art, while such tortures as blistering, cauterizing, scarification, and the use of the seton and fontanelle were common practice.* The seton was used by making two parallel incisions in the skin, usually on the neck, and by drawing a thread or piece of linen through the channel thus made. By thus drawing this material through the wound a constant irritation could be kept up. This was believed to counter any skin irritation. The fontanelle was a small scarification which was kept open by the insertion of a pea or bean or similar foreign body. Numerous drugs drawn from a wide range of sources were in use, and their functions frequently correctly known. The magical belief in the virtues of precious stones, bezoar stones, and pearls was widespread.

To sum up, the medicine of the Fifteenth Century consisted largely of a mixture of magic, superstition, *post hoc* inference, and an abject adherence to experimentally untested traditional doctrine. The large and commodious hospitals which were first built during the latter part of this century were intended to alleviate the miserable lot of the poor sick, and were an expression of the dawning humanism of the period. The medicine of the Fifteenth Century was the medicine of the Dark Ages, and forcefully illustrates the truth that when men abdicate their hard-won right to think freely and to weigh evidence independently — no matter how challenging their conclusions may be to entrenched orthodox theory and doctrinaire practice — they lose not only the ability to gain new knowledge but forget the best of what has already been acquired. With the discovery of the wealth of ideas contained in the classical texts which broke upon the intellectual horizon of the latter half of the Fifteenth Century, the stimulus toward the rebirth of the independent spirit of inquiry, of observation, and of criticism began slowly to work like a ferment.

That there was in the Fifteenth Century an independent spirit like Leonardo da Vinci (1452–1518), pursuing investigation into the anatomy and physiology of the human organism and piling original discovery upon original discovery in the best spirit of the modern scientist, is a tribute rather to the supreme genius of Leonardo, whose work remained unpublished until the Nineteenth Century, than to the ethos of his time.

In passing it is necessary to observe that the Fourteenth and Fifteenth Centuries were periods during which the unity of religious theory was in process of breaking up. The subsequent disunity prepared the way for the Reformation of the early Sixteenth Century, and also assisted in providing that intellectual climate in which new and challenging ideas and practices could obtain a bearing free from the bonds of ecclesiastical scholasticism.



A wood engraving from De Fabrica *of Vesalius, published in 1543. Illustrations such as this established a new high standard of accurate portrayal and artistic ability in the medical works of the times.*

The new spirit of Renaissance medicine did not spring suddenly into being but had its beginnings in the Fifteenth Century with a period of transition extending from the latter half of the Fifteenth to the beginning of the second half of the Sixteenth Century. There is one work which can be said to mark the birth of modern medicine, however. That work is the *De Humani Corporis Fabrica* of Andreas Vesalius. The *De Fabrica* is the foundation stone upon which the great superstructure of modern medicine has been erected. It is a complete textbook of human anatomy. In addition to being the most important medical book ever published it is also perhaps the most beautifully printed. This magnificent work was published on June 6, 1543, at Basel† in Switzerland when the author was in his 29th year.

André Vesal, or in the Latin form of his name by which he is universally known, Andreas Vesalius, was

* The practice persisted until the middle of the Nineteenth Century, as may be seen from such an article recommending it as late as 1843. G. Wallis, "Some cases showing the advantage of powerful counter irritation, especially the long issue on the calvarium," *Transactions of the Provincial Medical and Surgical Association* (London), **II**:307–336 (1843).

† A few days earlier at Nuremberg *De Revolutionibus Orbium Coelestium* of Nikolaus Copernicus was published, May 26, 1543.

born at Brussels in 1514. He studied medicine at Louvain and Paris, and became professor of anatomy at the University of Padua in 1537 when he was 23 years of age. At Paris Vesalius had as his teacher the brilliant, but somewhat crotchety Jacobus Sylvius (Jacques Dubois or "Jock o'the wood," 1478–1555). Sylvius, who took his medical degree when he was 51, was an extraordinarily learned physician and commentator who attracted students from all over Europe. His *In Hippocrates et Galeni physiologiae partem anatomicam Isagoge* (Paris, 1642), is an able systematic anatomy.

Vesalius was fortunate in his teachers, though he afterwards criticized them not without some severity. In any event Vesalius did not like the manner in which anatomy was taught since it provided practically no opportunity whatever for the student to do his own dissection. Nevertheless Vesalius himself tells us that because of his superior skill he was asked by his teacher and fellow students to dissect the body for them. This was in 1535 and 1536. In the latter year the medical school at Paris dispersed, owing to the invasion of Provence by Charles, and Vesalius returned to Louvain where he lectured on anatomy and dissected the body. In December, 1537, Vesalius was appointed professor of surgery at Padua, and at Venice in April, 1538, he published a work of six anatomical plates, *Tabulae Anatomicae Sex*. Three of the figures, which were made by Stephan van Calcar a pupil of Titian's, showed the portal, vascular, and generative systems, and the remaining three, the skeleton. The latter plates were far superior to anything that had previously been published, and represent one of the earliest attempts at accurate anatomical delineation. Between 1538 and 1542 Vesalius was engaged upon the writing of his *De Fabrica*, and, as we have already said, this was published in June, 1543.

Castiglioni: A History of Medicine

Copper engraving of Paracelsus, whose insistence on careful observation and experimentation during the first half of the Sixteenth Century greatly aided in establishing medicine on a scientific foundation.

In *De Fabrica* we have, for the first time, a consummate textbook of human anatomy, illustrated with the most superb figures. Indeed the illustrations have never been surpassed in beauty and up to that time had not been anywhere nearly as accurately done. The book which constitutes the great foundation stone of medicine is at one and the same time the first work which exhibits the true method of science. In this work Vesalius proved that progress in medicine required research. The workings of the human body were not to be learned from books, but by going to the book of nature itself, the working of the human body could be learned by investigation and observation based on experiment. The importance of *De Fabrica* in putting human anatomy on a firm scientific foundation cannot be overemphasized in the subsequent development of medicine, for anatomy was and is to medicine what the alphabet is to reading and writing. Without the one it would be impossible to grasp the other.

Vesalius was a genius and a somewhat conceited and bumptious young man, as geniuses sometimes are apt to be. The preface to his book becudgels and belays the medicine of his day and its practitioners. It overexaggerates and overclaims, and makes insufficient acknowledgment of the work of his predecessors. Moreover, Vesalius was not one to hide his light under a bushel, and he pretends to a knowledge of Greek, Arabic, and Hebrew, which he did not possess. There is a good deal of fustian in his work and much that is Galenic. The spirit of the red-cheeked, apple-stealing bright boy who is the only one who knows how the model-T Ford and the radio set work is very evident in his preface. Vesalius' attitude and lambastings did not sit well with some of his contemporaries, and there are some who hold that it were better if his preface had never been written. On the whole, its effect was probably good. It annoyed some fools and caused them further to prove themselves the kind of dunderheads Vesalius said they were. An outspoken man is, of course, rarely popular, and while his book did little to advance Vesalius himself, it was immediately accepted by those who could value such works for the great contribution to knowledge which it was. With its publication the modern era in medicine can be said to have begun, and Copernicus' *The Revolution of the Heavenly Bodies* and Vesalius' *Construction of the Human Body* are to be regarded as the two works marking the renaissance of modern science.

The work of distinguished predecessors – such as Giacopo Barengario da Carpi and Nicola Massa – influenced the development of Vesalius but to these men he makes little or no acknowledgment. Giacopo Barengario da Carpi (c. 1470–1550) completed his *Anathomia Mundini* in 1514, and *De Calvariae* in 1518. His *Commentaria*, published in 1521, is the earliest anatomical work with figures illustrating the text, and a later work, *Isagogae Breves* which appeared in 1522 is the first anatomy illustrated in the modern sense. These books are all highly original works. Nicola Massa (c. 1480–1569), general practitioner of Venice, is another to whom Vesalius was

(*Continued on page 346*)

Glaskogels

From Whence Came the Bohemian Green Glass Shards?

Several Hypotheses Have Been Advanced but

the Mystery Still Remains Unsolved

By **WILLY LEY**

FACING me, while writing this, there is a small glassine envelope, such as stamp collectors use. It contains a small sliver of a glassy substance, about as large as a fingernail and slightly thicker than a nickel coin. Its color is a beautiful dark green, especially when you look through it, and it is quite heavy. The correspondent who sent me the piece wrote that his father, an immigrant from Bohemia, picked it up in a field in his native country many years ago. His son now wants to know whether it might be a moldavite. Considering circumstances and appearance, it probably is, although it would need examination with a microscope and even chemical analysis to be absolutely certain.

The story behind those green glassy shards that could be (and probably still can be) picked up from Bohemian fields when a ditch was dug, or when a small stream bit a few feet deep into the surface soil, cannot be said to have a real and definite beginning. To the Bohemians these green shards "were always there" and, when encountered, were as little reason for surprise as is the finding of a piece of amber to a fisherman on the shores of the Baltic Sea. The unfortunate difference was merely that a piece of amber had commercial value while the green shards did not. Still, they must have acquired some fame as local curios because their existence was mentioned by Johann Wolfgang von Goethe in his miscellaneous scientific writings where he said: "the so-called Bouteillenstine is found at Kornhaus near Schlan." The geographical location mentioned is Bohemian, while the French-German hybrid word *Bouteillenstein* means "bottle stone," – green glass.

The pieces of bottle stone found were never large; a piece that could be compared in size to an egg was already very unusual. The majority varied in size between a hazelnut and a walnut. Many had a blackish crust as if the surface, and the surface only, had been molten at one time. A few looked almost like Prince Rupert's drops with a long tail. Those that had a black crust often showed little cusps in that crust, as if a bellows had blown against it when it was soft. Most of them were simply broken pieces, just like shattered glass. Chemical analysis proved that they were glass; most precisely, they were of the type of glass which is better known as obsidian or volcanic glass.

Once this became known, the mystery of the shards seemed to have been solved. In the meantime they had been given a name. Since they came from Bohemia, and Bohemia's best known river is the Moldau or Moldova, they had been named "moldavites." It was found that the shards greatly resembled volcanic glass chemically, and there were a few extinct volcanoes around. Hence it came easy to believe that the moldavites were leftover results of former activity of now extinct Bohemian volcanoes.

This theory sounded beautifully simple and convincing, but a few things simply refused to fit in with this idea. The Bohemian shards greatly *resembled* obsidian, but there was still a difference, literally a microscopic difference. True obsidian, taken from the immediate vicinity of volcanoes which once produced it, always shows large numbers of fine crystallic needles imbedded in it when examined under the microscope, but the moldavites did not. Of course, it was possible that the Bohemian volcanoes, when still active a million years or so ago, had produced a different variety of obsidian. But why did all other volcanoes produce shards of the same type, and all with needles?

Which Bohemian volcanoes yielded these green pieces was another very puzzling question.

Moldavites were first known to be comparatively plentiful near Budweis in the area of the Upper Moldau. A second area, a few miles wide and about 30 miles long, was then discovered in Moravia, east of Trebitsch. Both regions combined covered an area more than 100 miles long but only 10 to 15 miles wide, if that much. Had there been a line of extinct volcanoes extending through the approximate center of that area the theory of volcanic origin could have been supported. But there were no extinct volcanoes near the Bohemian end, and certainly none at the Moravian end of the region in which the moldavites were found.

Meanwhile, enterprising Bohemian jewelers had put the shards to use. They were easy to grind and looked very beautiful when faceted. At first the use of moldavites for jewelry may have been undertaken in the spirit of honest imitation; they made fine substitute emeralds for those who could not afford real ones. Because of their beauty they quickly came into demand and "Bohemian chrysolite" became an article of commerce. Probably for the sake of those who might stumble over the word "chrysolites" they were also labeled "Bohemian green garnets."

A new hypothesis came into being when Alexander Makowsky of Brno, or Brünn, declared that those green stones were neither a variety of chrysolite, nor a kind of garnet, or a species of obsidian; in fact that

they were not natural stones at all. He pointed out that they differ in structure from obsidian and that there were no extinct volcanoes around to begin with, even if one admitted that the Bohemian volcanoes should have been the only ones to produce a different kind of obsidian. On the other hand, Bohemia has always been famous for its glass. Bohemia not only produces very beautiful and very famous glass, but also large quantities of it. Thus did Makowsky conclude that moldavites are merely remains of an old and forgotten Bohemian glass industry. True, historical records did not say anything about such an industry, but this was not strange. Largely because of the political upheavals through which it has passed, historical sources about ancient Bohemia happen to be small in number. Those accounts that do exist lack any information about industrial history, which is understandable because they were written by clergymen and noblemen, not by artisans. The ancient artisans did not write chronicles; they were busy making good Bohemian glass.

Makowsky was not alone in his contention. Almost half a century before, a man named Martin Pokorný had made the same guess and used very similar arguments. Since there was no good natural explanation for the moldavites, the alternative, that they were artificial, was accepted.

But there were two sides to the story. If they were artificial, pieces of moldavite did not belong in a museum of natural history, side by side with samples of obsidian and other volcanic products. The curators of the museums got busy; they removed samples of moldavite before some newspaperman who might have happened to have read Makowsky's treatise could make fun of them. Obviously, the artificial moldavites belonged in industrial collections, and they should be placed next to complete products of those old Bohemian glassmakers. Since the ancient artisans had left so many pieces lying around they must have produced a great deal of glassware. Surely, then, there must be bowls, or cups, or vases of just that type of glass in collections of old glassware.

In spite of the large production indicated by the extent of the slag found, no complete or even chipped and broken pieces seemed to have survived. No bowl, or cup, or vase of moldavite could be discovered anywhere. It was strange that all products fashioned from moldavite should have been broken in the course of time, particularly since green Bohemian glass did not break easily. In fact the manufacture of Bohemian glass must have been a special trade secret since moldavite was a truly unique kind of glass. No other glassmakers ever produced glass like moldavite; just as no other volcanoes had produced the kind of obsidian found in Bohemia — if one thought back to those days when people still believed that moldavite might be volcanic in origin.

Once more the facts did not support the theory, and even Makowsky's ingenious and promising arguments proved to be merely another blind alley. That there was no record of the ancient industry was just barely possible, even though most improbable in view of its extent. It was also possible for the old Bohemian glassmakers to guard their trade secrets so jealously that no other artisans, living or dead, could produce their peculiar type of glass. But that nothing but slag and refuse remained of a widely practical ancient industry was beyond reason.

One had to accept some explanation of the origin of the moldavites. They were either natural or artificial; there was no third choice. But after reading all the arguments on both sides of the question, one was forced to conclude that they could be neither natural nor artificial. Such a conclusion obviously was nonsense.

Then, in 1898, a really great geologist, Eduard Suess, surveyed the whole question, went over all known facts, relevant and otherwise, and found a way out. The inexplicable moldavites lost their mysteries if one assumed a natural origin for them — *but not on earth!* In other words, their distribution and characteristics could be explained if one took them to be of meteoric origin.

Much of Suess's argument was based on the fact that the green shards were no longer a specifically Bohemian phenomenon. Samples of "glass," like the Bohemian variety, had been found in the Swedish district of Skåne or Schonen. Following the example of naming the shards after the geographical region in which they were found, the Swedish samples were called "schonites." Chemical analysis proved that schonites were the same as moldavites, both being glass of rather high melting point with more aluminum and less calcium than is customary. There was no extinct volcano to account for them in Sweden and the history of the Swedish glass industries was clear, too. By the end of the Nineteenth Century there were also numberless australites in collections, most of which had been dug up in the Australian gold fields following the discovery of gold in Australia on February 12, 1851. The australites showed the influence of heat much better and more clearly than even the most typical moldavites. Some of them had a pronounced mushroom shape; a few looked like dumbbells, or rather, hourglasses. In a few rare cases they were almost perfect glass spheres, two to three inches in diameter with a wall thickness of less than a quarter of an inch! Suess reminded his readers that Charles Darwin had described a "volcanic bomb" of "obsidian" in 1844 and that Darwin himself had emphasized that the spot where that "bomb" had been found on the Australian mainland was hundreds of miles from any active or extinct volcano which possibly could have produced it.

And if the moldavites were scattered over an area a hundred miles long, the australites were scattered over thousands of miles, their distribution reaching south to Tasmania. The man who knew the australites best, a certain Alfred W. Stelzner, was satisfied that no chemical difference existed between australites and moldavites. Stelzner was also satisfied that their shapes could be explained only by assuming that they had traveled through the air at high speed in a molten or semimolten condition. Having gone that far, Stelzner naturally thought of the possibility that australites might be of meteoric origin but felt that this was an unnecessary hypothesis. Volcanoes could have thrown molten materials through the air with high speed, and

(*Continued on page 358*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

To Public Service

BEFORE retiring from President Truman's cabinet, one of the last official acts of James Forrestal, Secretary of Defense, was the naming of Professor Philip M. Morse, of the Physics Department at the Institute, to serve as research director and deputy director of the Weapons Evaluation Group of the National Military Establishment. Professor Morse will be the chief scientific authority in the agency whose primary duty will be to conduct operational research for the Joint Chiefs of Staff and also for the Secretary of Defense, on leave of absence from M.I.T.

The group which Professor Morse will head is now being formed with the assistance of the Research and Development Board of the National Military Establishment headed by Dr. Karl T. Compton. After organization it will report to the joint chiefs of staff and the secretary of defense.

During World War II, Professor Morse headed a group of scientists engaged in operational research. His outstanding ability in this line of analysis, which is summarized in his article "Of Men and Machines" in the November, 1946, issue of The Review, was signalized by the award of the Medal for Merit and is largely responsible for his present appointment. After the end of the war, Dr. Morse was one of the originators of, and first director of, the Atomic Energy Commission's Brookhaven National Laboratory at Upton, Long Island, operated by Associated Universities, Inc.

Council Miscellany

C. GEORGE DANDROW, '22, Alumni President, presided at the 267th meeting of the Alumni Council on February 28 when 108 members and guests were present at the Campus Room in the Graduate House. During the usual order of business, Daniel G. Hulett, '42, Secretary-Treasurer of The M.I.T. Club of the Kanawha Valley, was introduced as one of the leaders in starting that club three years ago.

Six Faculty and staff members were reported as having visited 13 Technology clubs between February 8 and 28, from Springfield, Mass., to Monterrey.

Looking toward the 1949 Alumni Day on June 11, it was reported that the Executive Committee had appointed a Committee on Alumni Day Planning to consist of Horatio L. Bond, '23, chairman, James Donovan, '28, and Malcolm G. Kispert, '44. Elected at this meeting of the Council were the following committee personnel in charge of Alumni Day, 1949:

Banquet: Robert L. Johnson, '38, chairman, George Warren Smith, '26, James B. Smith, '32, and Rutherford Harris, '37; *Class Day:* John A. Hrones, '34, chairman, Eugene Mirabelli, '19, and Kenneth R. Wadleigh, '43; *Exhibits:* William H. Brown, '33, chairman, Ernest P. Neumann, '38, Frederic W. Watriss, '41, Robert V. Bartz, '44, and Gyorgy Kepes, Staff; *Ladies' Program:* Mrs. B. Alden Thresher, chairman, Mrs. Horatio L. Bond, Mrs. Karl T. Compton, Mrs. Marshall B. Dalton, Mrs. C. George Dandrow, Mrs. Ar-

Class Reunions

The secretaries of the following classes have announced reunion plans and get-togethers to be held in 1949 as noted below:

1894 June 10 and 11. 55th reunion celebration. June 10, at a nearby suburban country club; June 11, at M.I.T. Alumni Day activities. Details in class letter.

1899 June 9 and 10, tentative dates. 50th reunion celebration. Time and place yet to be determined.

1904 June 24–26, East Bay Lodge, Osterville, Mass. Carle R. Hayward and Eugene H. Russell, Jr. in charge of plans.

1909 June 17–19 week end. Friday afternoon through Sunday. 40th reunion. East Bay Lodge, Osterville. Accommodations available for anyone who wishes to come earlier or stay later. Reunion Committee: James H. Critchett, Chester L. Dawes, George A. Haynes, Arthur L. Shaw, Henry K. Spencer, Paul M. Wiswall. See March Review, page x.

1914 June 17–19, Sheldon House, Pine Orchard, Conn. Reunion chairman, Charles P. Fiske.

1919 June 24–26, Norwich Inn, Norwich, Conn. Reunion Committee chairman, Wilfred O. Langille, Diehl Manufacturing Company, Somerville, N.J.

1924 June 8–11, East Bay Lodge, Osterville. George E. Parker, reunion chairman.

1929 June 12–14, Sunday afternoon to Tuesday morning. East Bay Lodge, Osterville. John J. Wilson, Jr., chairman, 255 Beacon Street, Apartment 54, Boston 16. See March Review, page xx.

1934 June 9–11, Ye Castle Inn, Cohen Field Point, Saybrook, Conn. Informal supper, June 9; class banquet, June 10; program ends after breakfast, June 11.

1939 June 17 and 18, Mayflower Hotel, Plymouth. Frederick B. Grant, 22 Edmunds Road, Wellesley Hills 82, Mass., in charge of plans.

1944–2 June 10, Campus Room, Graduate House, M.I.T., Cambridge. Plans for a dinner and entertainment are being formulated. Malcolm G. Kispert in charge.

1944–10 June 10, tentative date. Dinner at Hotel Sheraton, Boston. James B. Angell, M.I.T. Graduate House, in charge of plans.

If you are interested in M.I.T. class reunion plans, please consult your individual class secretary for additional information which may be available at a later date.

thur L. Hamilton, Mrs. Robert L. Johnson, Mrs. Henry B. Kane, Mrs. James R. Killian, Jr., and Mrs. William J. Kirk; *Luncheon:* William J. Kirk, '28, chairman, Frederick H. Kienle, '27, Rudolf S. Slayter, '28, and Ariel A. Thomas, '36; *Publicity:* James Donovan, '28, chairman, Henry B. Kane, '24, Beverly Dudley, '35, Kenneth S. Brock, '48, and John J. Rowlands, Staff; *Reception:* Malcolm G. Kispert, '44, chairman, William H. Carlisle, Jr., '28, and Henry Loomis, Staff; *Registration:* Wolcott A. Hokanson, chairman, G. Edward Nealand, '32, and Robert E. Hewes, '43; *Transportation:* Emmons J. Whitcomb, '11, chairman, Malcolm S. Stevens, '34, and John L. Danforth, '40; *Ways and Means:* Delbert L. Rhind, Staff, chairman, Carl M. F. Peterson, '29, and Donald Whiston, '32.

Malcolm G. Kispert, Administrative Assistant to the President, acquainted the Council members with budget matters under consideration, and gave figures showing the growth of Institute personnel, services, and finances during the past decade. In addition, he spoke of some of the Federal legislation under consideration which, if passed, would affect collegiate housing, the National Science Foundation, and the Universal Military Training program.

John E. Burchard, '23, Dean of Humanities, next presented the history of the convocation and inauguration program to take place in Cambridge from March 31 to April 2, and enumerated the speakers who would participate, as recorded in the March issue of The Review. He also presented a résumé of the problems which have come about as a result of the very great interest on the part of Alumni and friends of M.I.T. to attend the convocation and inauguration, and hinted (as has been subsequently confirmed) that only the Boston Garden would be large enough to accommodate those who planned to attend.

Warren K. Lewis, '05, Emeritus Professor of Chemical Engineering, then introduced the speaker of the evening, Glenn C. Williams, '42, Associate Professor of Chemical Engineering, who spoke on jet propulsion. Professor Williams presented an able historical summary of progress in this field and outlined the several types of jet-propelled missiles which have been investigated. He elaborated his lecture by indicating the relative efficiencies, velocities, and fuel consumptions of the different types, including the ramjet which had been developed at Technology and had been the first one tested in flight in the United States.

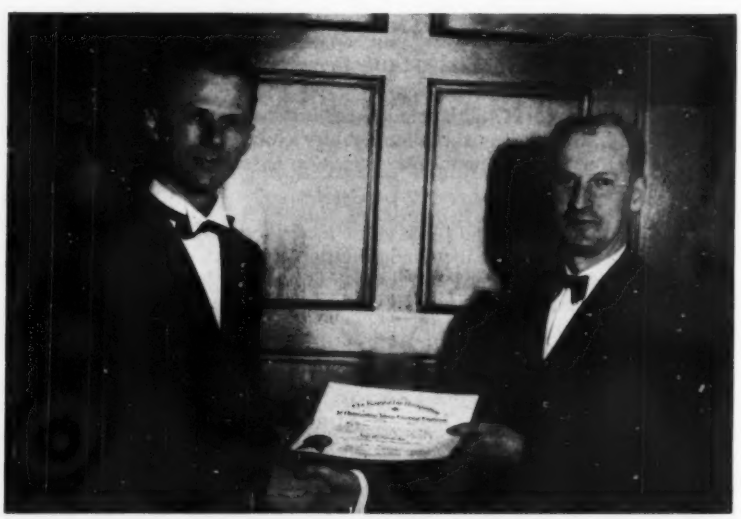
Economics of Housing

THE Merrill Foundation for the Advancement of Financial Knowledge recently has made available to M.I.T. a grant of $50,000 for a research program on the economics of the housing industry. Winthrop H. Smith, President of the Foundation and managing partner of Merrill Lynch, Pierce, Fenner and Beane, announced that the study would be carried on in the Department of Economics and Social Science at M.I.T. under the direction of Professor W. Rupert Maclaurin and a staff of experts.

The program, which will form the basis for the study by Professor Maclaurin and his associates, includes investigation of such factors as unit operations, building codes and zoning restrictions, building trades' union practices, the relation of component manufacturers to the building industry, site developments, and the attitude of home owners toward the practice of standardization.

Professor Maclaurin said that the studies will be focused on what has been done and what can be done operationally to overcome the various handicaps which have retarded the advancement of the industry, and it is hoped that the study will result in measures to bring order and stability to the housing industry. It is expected that a number of leading concerns

Honored for Electrical Engineering



Jay Wright Forrester, 6–45, Associate Director of the Servomechanisms Laboratory, received one of the two honorable mentions in the selection of the outstanding young electrical engineer of 1948 by the Jury of Award of Eta Kappa Nu, national honor society for electrical engineers. He is shown here receiving the award certificate from T. W. Williams, President of Eta Kappa Nu.

The Eta Kappa Nu Recognition Award is made annually "for meritorious service in the interest of their fellow men" on the part of young electrical engineers, not only for their technical ability and accomplishments already achieved, but also for their interest in cultural and civic advancement and their promise for future development. To qualify for the award, candidates must not be older than 35 years, nor be out of college more than 10 years by May 1 of the year for which cited.

Following graduation from the University of Nebraska in 1939, Mr. Forrester came to the Department of Electrical Engineering at M.I.T. as a graduate student and research assistant on the development of high-voltage electrostatic generators in the few-megavolt range and the application of these generators to the treatment of cancer. He also participated in the instruction of undergraduates. In 1940, he was assigned to a small group of research workers to develop servomechanisms for gunfire control, and he helped develop an hydraulic type subsequently used extensively on the antiaircraft weapons of both the United States Army and the Navy. Mr. Forrester's major technical contributions have come in the past three years while working in the field of digital computers.

Three views of the recently completed dwelling for research on solar energy for home use. The exterior views show the solar-energy collecting unit on the roof, which heats water in a 1,200-gallon tank located above the living quarters and adjacent to the panels which form part of the roof.

Maximum advantage is taken of all sunlight, as shown by the full-length windows in the living room (above), *the large windows* (left) *of other rooms of this dwelling, and the southerly exposure. The house is occupied by an M.I.T. student while research aims to determine feasibility of solar heating.*

M.I.T. Photos

in the building industry will co-operate in the study in order that all aspects of the problems of the industry may be thoroughly understood.

For Wintry Weather

THE sun is substituting for a furnace in New England's newest home, a four-room "solar" house recently erected on M.I.T. property on Memorial Drive, set aside for student housing. Opened to use during February, the unusual house will be occupied by a student family while M.I.T. engineers study the efficiency of their latest design for using radiation from the sun to warm the house throughout the winter.

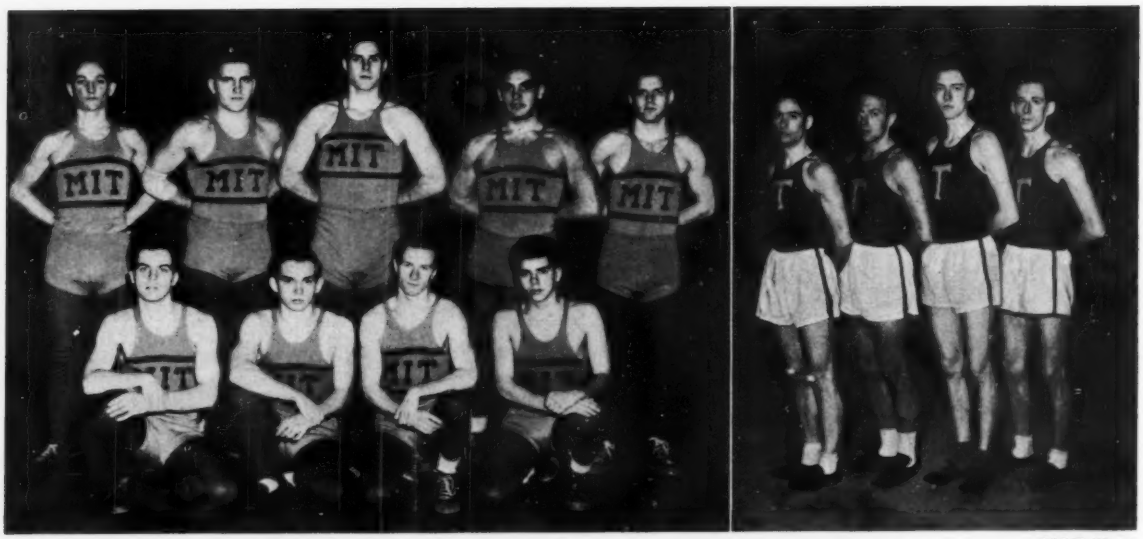
According to Professor Hoyt C. Hottel, '24, of the M.I.T. Department of Chemical Engineering, the house will be used for studies to determine the extent to which the sun can compete with conventional methods of heating. It is not now presumed that solar heating will be economically feasible in a climate as cold as that of New England, but the results of studies now in progress should serve to indicate conditions of climate for which solar heating is competitive with fuel oil, gas, or coal.

The new M.I.T. solar house has the appearance of a typical modern residence, except for its heat collector in the roof. It has two bedrooms, a kitchen, a living-dining room, and an instrument room in which the heat absorbed from the sun and that lost from the house during sunless hours will be continuously recorded by the instruments.

The heat-storing equipment is designed to keep the house at 68 degrees F., night and day, but supplementary electric heating units have been provided for long periods of sunless days during cold weather. Electric auxiliary heating, which will go into operation should the house temperature drop to 65 degrees, was chosen primarily because of convenience in experimental work of this type.

Water, warmed by the sun in a flat-plate collector located on the roof of the house, is used for storing and distributing heat. Once warmed by the sun, the water is pumped into an insulated tank in which it is held for use during sunless hours, when the house is warmed by the heat radiated from a panel in the ceiling. The storage tank holds 1,200 gallons of water. During an average January day, the temperature should rise a few degrees more than it falls at night, thereby slowly storing heat energy for use on sunless days. Present calculations indicate that this water should have sufficient heat capacity to maintain comfortable temperatures in the house for two sunless days of normal January weather. It is expected that not too much dependence will have to be placed on the auxiliary heating unit, for from a solar engineer's point of view, a truly sunless day is unusual in New England; even through light clouds, considerable solar heat is received.

The heat collector unit on the roof of the house is adapted from a unit studied in M.I.T.'s prewar solar heating research program. It slopes 57 degrees to the horizontal, faces south, and presents a net area of 400 square feet on which the sun's heat is received. The roof of the house is covered with aluminum, so that additional solar energy will reach the collector by reflection from the roof. In addition, a large window on



M.I.T. Photo

M.I.T. can boast of two outstanding sports accomplishments this past winter season. Freshman wrestlers are proud of two wins over Harvard, generally considered the best among the local grapplers, and also wins over Tufts, Springfield, and Wesleyan. The team consists of (front row, left to right): *Samuel L. Mitchell, Donald P. Brown, Lawrence J. Foley, Lawrence W. Mayer;* (back row) *Francis M. Frasher, Jr., Charles E. Bading, Robert J. Robertson, Eugene J. Rapperport, and Hugh Robertson — all of the Class of 1952. Technology's varsity track team set a new M.I.T. mile-relay record of 3:22.6 at the Millrose Meet in New York's Madison Square Garden on January 29, 1949. Four members of this team are* (left to right): *Alphonse J. Dell Isola, '50, Edward S. Olney, '51, Randall K. Cleworth, '49, and H. Douglas Vitagliano, '49.*

the south side of the house, opening into the living room, will collect additional heat during sunlight hours.

The collection and heating unit is a compact, closed-cycle system at atmospheric pressure; no outside air or water is introduced once operation is begun. The parts of the unit include the roof collectors, an attic storage tank, a radiant ceiling panel heating unit, two circulating pumps, and controls. Whenever the sun heats the water in the roof collectors to a temperature above that of the storage tank, a pump circulates the water from tank to roof collectors and back. Whenever the temperature of collector water is below that in the storage tank, the flow of water is cut off and the collector is pumped full of air to prevent freezing damage. Quite independently of this circulating system, whenever the room thermostat calls for heat, a second pump circulates water between the storage tank and the radiant ceiling panel.

The solar house is carefully insulated to reduce heat loss to a minimum. Windows have double panes of glass with air space between, and inside curtains will be drawn over them after dark to provide further insulation. The walls are insulated with four-inch pads of rock wool, Celotex, and aluminum foil. Despite the essentially research nature of the project, considerable effort has also been spent to make the house as attractive and comfortable a dwelling unit for student use as possible.

Designers of the new M.I.T. house decline to estimate the cost of a solar heating system for the average New England house (or even to say that such a system can be effective in as severe a climate as that of New England). The present design does not include expensive oversize equipment to provide capacity for extreme cold spells or sunless periods of a week or more. Instead, auxiliary electric equipment is provided to heat the water in the radiant ceiling panel under these circumstances. Hot water for domestic use in the solar house is heated independently by a conventional electric unit.

The instrument room in the house contains automatic recording equipment to measure the intensity of solar radiation, the amount of heat energy received from the sun, the amount supplied in the house by electric means, the temperature of the storage water, and the air temperature at various points in the house.

Since normal family activities will be proceeding in the solar house while tests are being made, M.I.T. scientists hope their automatic instruments will provide figures for heat loss and heat storage requirements under typical dwelling conditions, from which it may eventually be possible to estimate fuel savings and arrive at a practical figure for the over-all costs of solar heating.

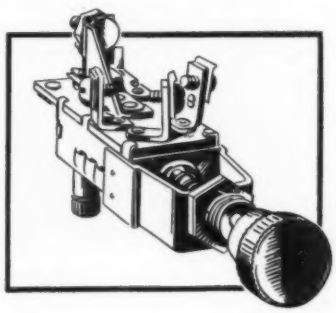
The house, part of an M.I.T. program of research into means of utilizing solar energy, was built with funds provided in a grant to the Institute by Godfrey L. Cabot, '81, of Boston. The solar energy work is under the supervision of a steering committee consisting of Professor Lawrence B. Anderson, '30, Head of the School of Architecture; Albert G. H. Dietz, '32, Associate Professor of Structural Engineering, Department of Building Engineering and Construction; August L. Hesselschwerdt, Jr., '31, Assistant Professor, Department of Mechanical Engineering; and Professor Hottel. The construction of the house and the research directly associated with it are directed by Edmund L. Czapek, research associate in the School of Architecture. The architectural design is the work of J. Franklin Haws of Pottstown, Pa., a student in architecture at M.I.T.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The device you see pictured here is an automobile light switch which controls parking and driving lights. Probably few motorists have ever seen such a switch, because the body of it is concealed under the dash or back of the instrument panel. People see only the knob. Because the operation of such a switch is so simple and reliable, probably most people think it is equally simple in design.

The fact is, however, that its simplicity and reliability of operation are protected by design and materials that foresee the conditions and contingencies of use. This is typical of a great many products which are taken for granted by people who never realize how much forethought has been given to the creation of hidden values that assure satisfaction.



Take the matter of selection of materials. The switch uses steel in several types and forms, brass, phosphor bronze, silver, canvas base bakelite, a felt washer to exclude dust, a plastic, and if you include the fuse, lead and glass. All told, there are some 20 main parts. Of these, four are made of Revere phosphor bronze, used for contacts, contactor, and rivets, these being the parts in which the special qualities of phosphor bronze are essential.

The fact that the use of Revere phosphor bronze is confined to four small parts illustrates a basic Revere policy, which is that we recommend Revere Metals only for the purposes for which they are better suited. If we were asked if we would recommend brass for the bracket and case, we would say that the steel being used is perfectly suitable, should last as long as the car, and has a minimum cost.

We like to sell Revere Metals, but not to our customers' disadvantage. Our Technical Advisors are in constant consultation with manufacturers and do not hesitate to suggest whatever material will enhance performance or save money. Recently, for example, one of these engineers found a customer using a phosphor bronze for a cover plate, and remarked that a certain nickel silver would serve as well and cost somewhat less, since it would have adequate springiness, strength, and corrosion resistance in that application. On the other hand, substitution of phosphor bronze for nickel silver has been recommended from time to time. It all depends upon the needs of the specific application.

This attitude of Revere's is by no means unique; it is to be found throughout American industry. The one essential to make it resultful is that the supplier be taken as far as possible into the manufacturer's confidence, because only then can the supplier's knowledge be made available.

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THE TREND OF AFFAIRS

(Continued from page 326)

field, being a new application, required a much more streamlined setup. Admittedly, such a diversity of organizational setups must have been quite a headache to the top administration. Yet the success of each of these divisions is a tribute to the judgment which permitted such flexible operations.

In retrospect, it is possible to interpret the net effect of the book into the following generalizations:

(1) The NDRC was able to perform research and development on a large class of scientific and technical devices which the services, by their rigid organization, were not in a good position to pursue;

(2) A fairly large fraction of the scientific effort of the United States went into the development of specific technical problems and measuring instruments whose integration into the over-all war effort was not clearly evaluated from the standpoint of national urgency. In this last connection the reader is permitted to ask the question whether the man power could not have been better used if it had been organized into large central research laboratories.

The chief criticism of the book as a whole is that it has not separated out of the large multitude of projects those which made a significant contribution to the war effort. This is particularly true in the metallurgical section which merely lists each project and leaves the evaluation entirely to the reader. On the whole, the book is a tribute to the co-operation of the large number of individuals and companies in pooling their information for the benefit of the nation. The book will undoubtedly serve as a valuable source of material for future historians. — I.A.G.

Raw Deal

THE anatomist says that man differs from his nearest relatives in the animal kingdom by possessing an opposable thumb; the philosopher differentiates man from the lower animals by the human ability to transmit ideas through spoken and written language. But an equally valid, if prosaic, point of differentiation is the fact that man is the only animal that cooks most of his food. Three reasons might be advanced for this custom: sanitation, nutrition, and flavor. But when such possible motives are examined, it is clear that only flavor is a governing influence.

Cooking, it is true, does promote the sanitary quality of foods, because cooking heat destroys important micro-organisms, toxins, and parasites. All of the microbes that cause intestinal disease are killed by ordinary cooking temperatures. There are two important food-poisoning toxins (nonliving poisons excreted by bacteria that act independently of the presence of the bacterial cell): one, the toxin of botulism, is destroyed by heat; but the other, the toxin of Staphylococcus

(Continued on page 344)

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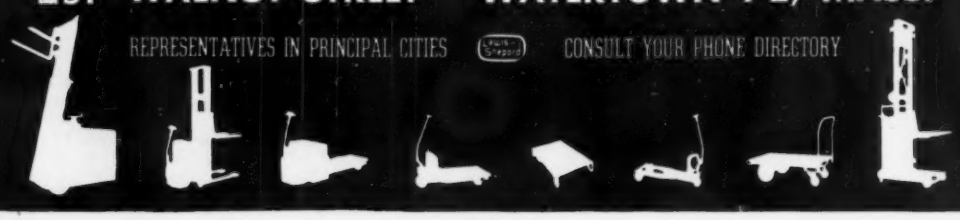

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C-646	Std.	1″	3-3/16″	2500	5150
CS-46	Ball	1″	3-3/16″	1250	3600
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THE TREND OF AFFAIRS

(Continued from page 342)

food poisoning, survives prolonged boiling. The parasites associated with foods are mainly worms that infest the intestinal tract. And it is only in this latter category that cooking is truly the primary means of making a food sanitary. The trichina parasites that may occur in pork, and that infest the human body when meat containing them is eaten, are destroyed when sufficient heat is used to cook the pork. Furthermore, thorough cooking of pork is the only entirely reliable means of preventing human trichinosis. In contrast, most other foods are kept sanitary much better by protection from infection or infestation while they are being grown or raised, harvested, processed, packed, and distributed.

The nutritive values of foods are in some respects improved, and, in some respects, worsened by cooking. Certain foods are made more rapidly or more completely digestible by cooking. But we are not concerned here with indigestibility in the sense of causing dyspepsia; the change in digestibility produced by cooking is a relatively small shift in rate or completeness of digestion, that can be measured by the physiologist but is not appreciated by the consumer. Cooked soya beans have higher protein value than raw soya beans. Raw clams interfere with effectiveness of the vitamin thiamine,* and raw egg white neutralizes the vitamin biotin. When cooked, both of these foods lose their antivitamin effects.

So much for random examples of the beneficial effects of cooking. On the detrimental side, cooking sometimes destroys portions of heat-sensitive nutrients, such as certain vitamins and amino acids. Even more important than destruction by heat are losses, by leaching, of water-soluble nutrients when water is used for cooking and then discarded. The high temperatures used in making puffed or exploded prepared breakfast cereals have been shown to reduce protein values. Nevertheless, most of the nutritional effects of cooking, both favorable and adverse, are of limited practical significance in a liberal, well-chosen dietary. In any event, it must be granted that nutritional considerations, like those of sanitation, rarely if ever motivate human beings to cook their food.

Legend holds that cooking originated when a pigsty burned and killed its tenants, whereupon the owner blundered upon the discovery that the roasted animals had a novel and delightful flavor. Although patently apocryphal, this tale is rooted in the fact that man's basic reason for cooking his food is production of tastes, flavors, textures, and other gustatory properties he has come to prefer. Thus the cereal grains, which constitute a major part of the human dietary throughout the world, are virtually inedible by the human being unless they are cooked, as in the boiling of rice and the baking of wheaten foods. Potatoes, another staple food, are extremely cloying to the human palate when raw. Other vegetables, such as car-

(Concluded on page 346)

* The Technology Review, June, 1946, page 480.

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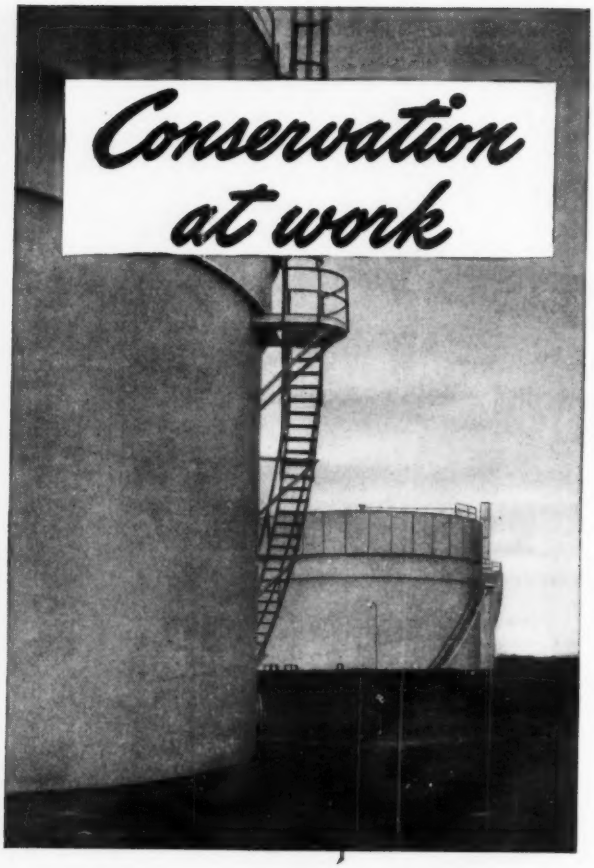

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THE TREND OF AFFAIRS

(*Concluded from page 344*)

rots or cabbage, are eaten either raw or cooked, but they must be shredded, grated, or otherwise altered in physical state to be generally acceptable when uncooked. Raw eggs are usually distasteful to human beings unless disguised in an eggnog. Some nuts are unpalatable when raw. Fish is practically never eaten uncooked; meat only in the form of the "tartar steak."

Thus, the sanitary effects of cooking are all to the good; and the nutritional effects, although divided between good and bad, are of minor significance in well-planned dietaries. Therefore, man need not gainsay the gustatory preferences that have led him to cook most of his food.

RENAISSANCE MEDICINE

(*Continued from page 334*)

almost certainly indebted. Massa's illustrated *Anatomiae Liber Introductorius*, published in Venice during 1536, was the best practical dissecting manual of its time. It was replete with original observations and discoveries based on the dissection of many bodies. Berengar and Massa were true Renaissance spirits and worthy forerunners of Vesalius.

But if the work of Vesalius is sufficiently outstanding to warrant fairly extended discussion, the work of other investigators must also be mentioned, even if briefly.

Following the publication of the *Fabrica* and its *Epitome*, both of which appeared at the same time, Vesalius' work was completed.‡ In 1546 he resigned his chair at Padua and became physician – first to Charles V, and later to his son, Philip II, of Spain. On returning from a visit to Jerusalem, his ship was wrecked on the Island of Zante, at the entrance to the Gulf of Corinth. There Vesalius died and was buried in an unrecorded grave in October, 1564.

Vesalius was succeeded at Padua by Realdus Columbus of Cremona (1516–1559). In 1559 Columbus published a work entitled *De Re Anatomica* in which he dealt with the lesser or pulmonary circulation. This account is almost in the words of Vesalius' fellow student, Michael Servetus (1511–1553), who had first described pulmonary circulation in a theological work *Christianisimi Restitutio* at Vienne in 1553, the year of his martyrdom.[5]

The anatomist who succeeded Columbus in the chair of anatomy at Padua in 1551 was Gabriel Fallopius of Modena (1523–1562). As an anatomist Fallopius proved himself almost as distinguished as Vesalius. His *Observationes Anatomicae*, published in 1561, contains numerous original observations and

(*Continued on page 348*)

‡ It is good to be able to say that, after 400 years, a translation into English of the *Fabrica* has been completed (by Professors John B. deC. M. Saunders and Charles D. O'Malley) so that Vesalius' extraordinary book may soon be read by those of us whose Latin is not equal to the task.

THE TECHNOLOGY LOAN FUND BOARD

Report for the Year 1948

Current principal repayments during the year again exceeded new loans made and by December 31, 1948, 2,098 – nearly three-quarters of the 2,791 receiving loans since the Fund was established in 1930 – had completely discharged their financial indebtedness to it.

The data given below summarize the Fund's transactions during 1948 together with cumulative figures for the past eighteen years.

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March 1, 1949

CUMULATIVE RECORD OF THE TECHNOLOGY LOAN FUND TO December 31, 1948

	At Dec. 31, 1948	*At Dec. 31, 1947*	*Net changes during 1948*
Items of Outgo			
Number of men Receiving Loans	2,791	2,708	up 83
Total Amount Loaned	$2,011,963	$1,956,190	up $55,773
Average Per Capita Loan	721	722	down 1
Items of Income			
Number of Men Whose Indebtedness has been Completely Discharged	2,098	2,015	up 83
Principal Repayments in Advance	$ 569,224	$ 558,649	up $10,575
Other Principal Repayments	1,081,444	1,032,494	up 48,950
Total Principal Repayments	$1,650,668	$1,591,143	up $59,525
Total Principal Matured, Considering "Advance Repayments" as Matured When Paid	$1,683,121	$1,623,724	up $59,397
Collection Ratio, i.e. Percentage of Total Maturities Paid	98.0	97.9	up .1
Matured Principal in Arrears	$ 25,335	$ 26,613	down $1,278
Actual "Written Off" Accounts	7,118	5,968	up 1,150
Total Maturities Unpaid	$ 32,453	$ 32,581	down $ 128
Percentage "Written Off" to Total Loans	0.3	0.3	—
Percentage Matured Loans in Arrears plus Amount Written off to Total Loans	1.61	1.66	down 0.05
Interest Received	$ 222,958	$ 215,836	up $7,122
Times Interest Received to Matured Loans in Arrears Plus Amount "Written Off"	6.9	6.6	up 0.3
Notes Outstanding	$ 354,176	$ 359,079	down $4,903

RENAISSANCE MEDICINE

(*Continued from page 346*)

discoveries, and a fair amount of respectfully expressed criticism of Vesalius.

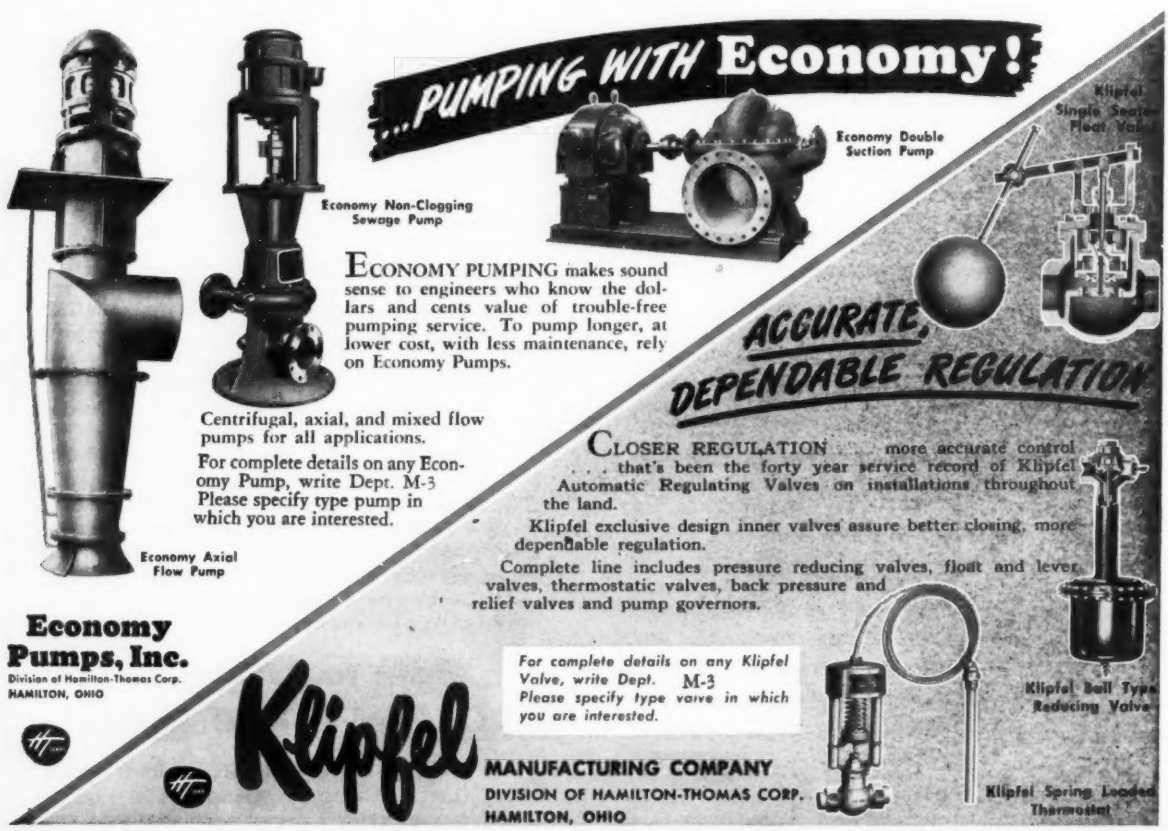
Three years after his death, Fallopius was succeeded at Padua in 1565 by his pupil, Hieronymus Fabricius of Aquapendente (1533–1619). Fabricius was a curious blend of Galenical interpreter and Vesalian methodologist and investigator. For more than 50 years he carried out observations on the embryology of the human fetus and the chick, and the anatomy and physiology of the venous circulation. By 1598 when the young Englishman, William Harvey (1578–1657), came to study with him Fabricius had discovered the valves of the veins. There is little doubt that through his lectures and demonstrations Fabricius exercised a capital influence upon the direction of Harvey's thought, and that this eventually resulted, in 1616, in Harvey's discovery of the circulation of the blood.[6]

At this period much work in embryology was being done by such men as Giulio Cesare Aranzio (1530–1589), Professor of Anatomy at Bologna. In his *De Humano Foetu Oposculum*, which appeared in 1564, many important observations were made, among which was the discovery that the maternal and fetal circulations were separate. He also gave some admirable anatomical descriptions of the fetal membranes. The Frisian, Volcher Coiter (1534–1600), made many valuable observations on the development of the chick and wrote and published in 1573 an admirably illustrated comparative anatomy.[7] Men such as Bartolommeo Eustachius (1520–1574) of Rome, Giovanni Filipo Ingrassias (1510–1580) of Naples, Costanzio Varolius (1542–1575) of Bologna at Rome, and the others already mentioned testify to the strength and dominance of the Italian school of anatomy which, as Haller remarked, taught the rest of Europe for a period of a century and a half.

The Italian school of anatomy had its most immediate effect upon surgery. Still, the outstanding surgeon of the Sixteenth Century was not a native of Italy but the Frenchman, Ambroise Paré (1517–1590). Paré was a military surgeon who, by making his own observations, brought an entirely new point of view to the treatment of gunshot wounds, which had hitherto been regarded as invariably poisonous. He eliminated the practice of treating wounds with boiling oil and instead substituted soothing applications. Further, he discarded the cautery to arrest bleeding after amputation and introduced simple ligature. Among other things he devised many new surgical instruments and invented the most ingenious artificial limbs. As the most eminent surgeon of his age, Paré, whose works were widely published and translated, raised surgery from a despised handicraft to a plane on a par with other branches of medicine.

It was during the first half of the Sixteenth Century that charters of incorporation were granted to the Guilds of Surgeons in Europe, and licenses to practice

(*Continued on page 350*)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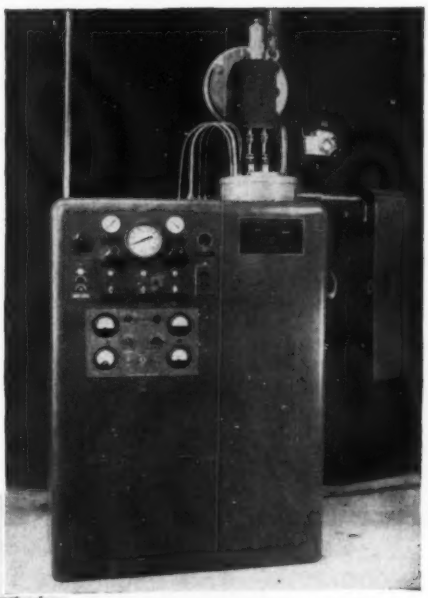

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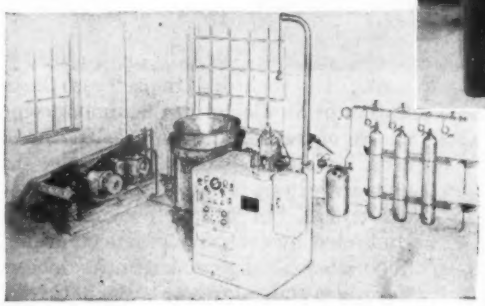

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RENAISSANCE MEDICINE

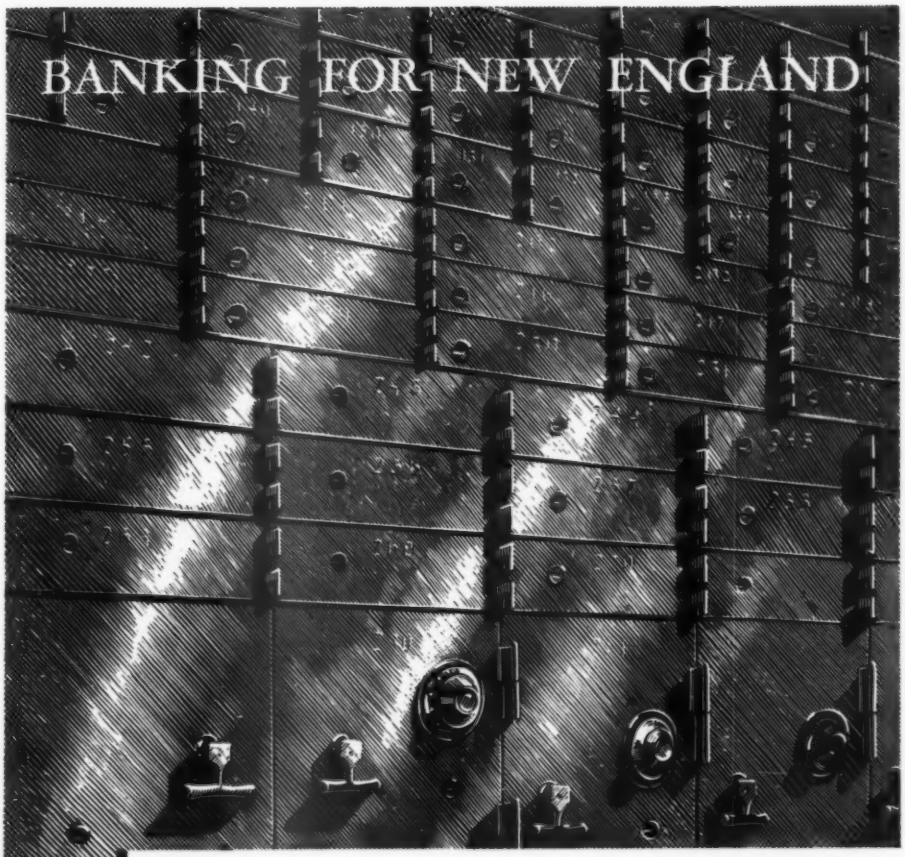
(*Continued from page 348*)

surgery were instituted. It was not until the latter half of the century, however, that surgeons acquired both repute and status. This was the age of itinerant lithotomists. These traveling removers-of-stones-from-the-bladder were regarded as many grades lower even than the surgeon. And yet among the lithotomists there were often men of great surgical ability and even genius, as may be illustrated by the case of Pierre Franco (1500–1561) of Provence, who like Paré had no formal training. Franco was the first to perform suprapubic lithotomy, an operation which was not again performed until John Douglas revived it in 1718. Franco invented a forceps for crushing stone, so that the fragments might pass more readily through the wound. He wrote a treatise on hernia, was first to describe the operation for strangulated hernia, and successfully performed operations for cataract.[8]

Here a few words may be in order about Theophrastus von Hohenheim (1493–1541), a great Renaissance spirit who has only in recent years come to be fairly understood. He was the subject of a long poem by Robert Browning, namely *Paracelsus*, the Latin name by which von Hohenheim called himself and by which he is generally known. As published by Karl Sudhoff, the collected works of Paracelsus run to 14 volumes[9] and cover the entire range of medicine and surgery in manner highly original for his day. His guiding principles were observation and experiment and a truculent disrespect for all authority drawn from books. He regarded himself as the reformer, the Luther of Medicine. In the announcement to his first course of lectures at Basel in 1527 he stated that the art of medicine had decayed. "But we shall free it from its worst errors. Not by following that which those of old taught, but by our own observation of nature, confirmed by extensive practice and long experience. Who does not know that most doctors today make terrible mistakes, greatly to the harm of their patients? Who does not know that this is because they cling too anxiously to the teachings of Hippocrates, Galen, Avicenna, and others?" "If I want to prove anything," he added, "I shall not try to do it by quoting authorities, but by experiment and reasoning thereon." Such words were not calculated to endear anyone to the medical faculty, and Paracelsus soon found himself on his wanderings again. His work in chemistry, pharmacology, and general medicine exercised a considerable influence, and was an inspiration to many who came under his fermentative power.[10]

Obstetrics made a good beginning in 1513 with the appearance of *Der Swangern Frauen und Hebammen Rosengarten* by Eucharius Rosselin (c. 1526). Translated into many languages (including English in 1540) as the *Birth of Mankind* and frequently reprinted until the end of the Seventeenth Century, it exercised a wide influence. It was Paré who reintroduced the ancient practice of podalic version, and restored the midwife to a responsible position. Paré's son-in-law, Jacques Guillemeau (1550–1613), carried the obstetrical ideas of Paré further.[11]

(*Continued on page 352*)



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RENAISSANCE MEDICINE

(*Continued from page 350*)

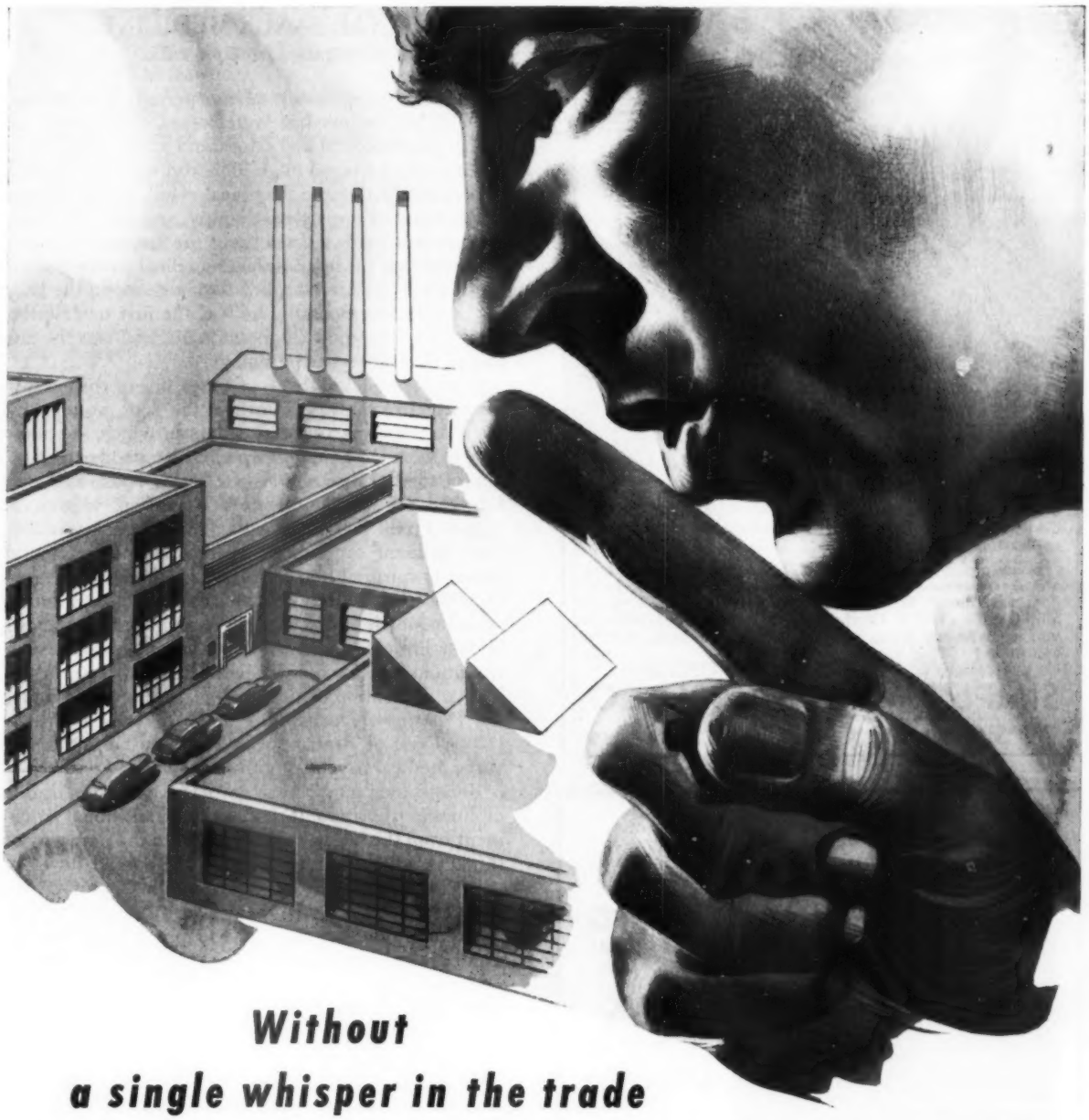
It was the Italian, Scipione Mercurio (1540–1616), who recommended Caesarian section particularly in cases of contracted pelvis. His book *La Comare o Raccoglitrice*[12] published in 1559 went through innumerable editions well into the Eighteenth Century. It was an extraordinarily good book and in addition to its sound obstetrical teaching contained much pediatric wisdom. At a time when well-to-do women were employing wet nurses he wrote: "It is barbarous to send the child away that has been in the mother's body, under her heart, and has fed with her own blood during nine months." Which reminds us of Jacoby's remark some 50 years ago that there is more intelligence in one breast of a mother than in the combined cerebral hemispheres of all the pediatricians put together. Pediatrics during the Sixteenth Century remained on the whole medieval, there having been no original contributions in this subject in this century, to knowledge.

In bacteriology, Girolamo Fracastoro (1478–1553), who gave syphilis its name, made an outstanding contribution to a rational theory of disease in his book *De Contagionibus*, published at Venice in 1546. He regarded infection as due to the passage of minute bodies from some infected source. "Infection," he wrote, "in the ordinary sense of the word is nothing else than the passage of a putrefaction from one body to another either contiguous with it or separated from it." Fallopius and Paracelsus had held similar theories as had Peter of Abano (1250–1316) in the Thirteenth Century. It was, however, Fracastoro who came closest to a germ theory of infection. There were no significant contributions toward pathology in this century, the few works published on this subject being chiefly compilations with some of the authors' own cases added. The most useful and complete of these works was published in two volumes at Frankfurt in 1600. This was *Observationum Medicarum Rarum* by Rembert Dodoens (1517–1585).

Pharmacological knowledge was still largely irrational and based on superstition and alchemy, but a sound basis in this field was being laid by Paracelsus, the one great experimenter and contributor of the century. It was he who introduced antimony into medicine, and he was the first to employ tincture of hellebore, tincture of compound of aloes, and tincture of metal or *Lilium Paracelsi*. The latter was prepared from alloys of antimony mixed either with iron, tin, or copper, and was served as a cordial.

What we today know as neurology and psychiatry began to make its first appearance during the Sixteenth Century when a trend to correlate disease with structure first became evident. This was no inconsiderable achievement in a period when ecclesiastical authority had turned knowledge of the human mind, especially in its aberrant functioning, into a codified demonology. It is well to recall that men like Ambroise Paré believed in witches, as did the great and gentle Sir Thomas Browne, author of the *Religo Medici* in the Seventeenth Century. One of the great medical hu-

(*Continued on page 354*)



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RENAISSANCE MEDICINE

(Continued from page 352)

manists and contributors of the period, Jean Fernel (1497–1558), believed in werewolves. Fernel took as nearly psychological a view of mind as was possible in his time. He believed in an immortal soul, and placed its corporeal habitat in the pineal gland. He was aware of the value of suggestion-therapy, and published the most rational views concerning the treatment of the mentally ill of his time. Fernel's medical writings were transitional in character, but they are among the best of the time. Incidentally, he was the first to describe what we today know as appendicitis, and was the author of the first text on pathology.

Félix Plater (1536–1614) of Basel, one of the earliest supporters of Vesalius, north of the Alps, voluntarily lived in the dungeons and cellars in which the mentally ill were kept, and emerged with a good classification of mental diseases. Again, in his book, *Von den Krankheiten so die Vernunfft Berauben,* written in 1526 but published at Basel in 1567, Paracelsus makes some brilliant suggestions, such as that most mental illness is spiritual and and has absolutely nothing to do with demons. He also states that hysteria is due to sexual conflict, and actually refers to the unconscious fantasy life of children as being associated with such conditions as chorea or hysteria. Perhaps the most effective demolition of demonology is the monumental *De Praestigiis Daemonum,* 1563, of Johann Weyer (1515–1588) of Brabant which greatly helped to divorce medical psychology from theology.

Renaissance medicine is seen as a congeries of disciplines in transition. It represents a transitional movement from the old way of believing to the new way of thinking which was to have its full-bodied development in the next, in the Seventeenth Century. Men were attempting to free themselves from the depressing tyranny of ecclesiastical thought, from scholasticism, and as Shakespeare put it, the "base authority [derived] from other's books"; to observe and experiment for themselves. This was the "New Philosophy," which as John Donne wrote "calls all in doubt."

Of that philosophy, which in medicine has been built by such men as Vesalius, Fallopius, Paracelsus, Fernel, Weyer, and many others, we are the direct benefactors. Suffering from a decay of the human spirit, we need today a revival of the spirit of the humanitarian men of the Renaissance. Today man knows more about the relation of atoms than he knows about human relations. Unless he cultivates the knowledge of human relations at least as assiduously as he pursued the quest of the atom, man will become as extinct as the dodo. It has become increasingly clear that, if civilization is to continue, scientific thought must be applied to man himself as a social creature.

References

[1] For an account of Salernitan medicine, see Castiglioni, A., *A History of Medicine,* pages 300–322 (New York: Alfred A. Knopf, Inc., 1947), $10.00.

[2] Cushing, Harvey W., *Life of Sir William Osler*, page 1081 (New York: Oxford University Press, 1940), $5.00.

[3] Ellis, E. S., *Ancient Anodynes*, pages 137–138 (London: William Heinemann, 1946).

[4] Robin, P. A., *The Old Physiology in English Literature* (London, 1911).

[5] He was burned at the stake for heresy at the instigation of Calvin, October 27, 1553.

[6] Apparently Fabricius took as his motto, *Pauca sed natura*, which was later also adopted by Karl Friedrich Gauss. Fabricius' work on the valves, *De Venarum Ostiolis*, was not published until 1603 in Venice; his early embryological works, *De Formato Foetu* and the *De Formatione Ovi, et Pulli*, were not published until 1604 and 1621, respectively.

[7] *Externarum et Internarum Principalium Humani Corporis Partium Tabulae et Exercitationes*, Nuremberg, 1573.

[8] See his *Traité des Hernies*, Lyon, 1561, the revised edition of an earlier work, *Petit Traité*, published in 1556.

[9] Sudhoff, Karl, *Theophrast von Hohenheim gen. Paracelsus Sämtliche Werke*, 14 volumes, Munich, 1922–1933.

[10] See the excellent essay *Paracelsus* by Henry Sigerist in the *March of Medicine*, pages 28–51 (New York: Columbia University Press, 1941).

[11] *L'Heureux Accouchement des Femmes*, Paris, 1609.

[12] *The Woman's Friend or Midwife.*

MECHANIZED SELLING

(*Continued from page 330*)

relatively new "Keedoozle" store. This attempt at a completely mechanized store is partially vitiated by the fact that there is still a human clerk at the end of the line to total up the bill and receive payment. One reason why the cashier in the grocery store is going to be hard to displace is that the size of the usual bill makes the transfer of paper money mandatory.

The patron entering a Keedoozle store first picks up a so-called key that looks rather like an intricate hand stamp. In this key is a roll of paper similar to that used in office adding machines. Instead of having open shelves from which the customer helps himself, this store is lined with glass enclosed cases in which the goods are displayed. The customer goes to a case containing an item he wishes and inserts the key into a receptacle under the case. He then presses a series of buttons, lettered to correspond with the items on display and the number of units desired. As these buttons are depressed, the paper is punched with a series of coded patterns. When the customer has completed his selections, he surrenders the key to the cashier who removes the roll of punched paper. The punched strip is then run through a machine that actuates a series of controls in accordance with the holes punched thereon. These controls select the items chosen by the customer and place them on a conveyer belt which carries them to the customer – and the cashier. The analogy with punch card and computer techniques is close.

Among the advantages claimed for this type of store are greater sales per square foot of floor space, reduced pilferage (estimated to yield sufficient savings to cover the royalties on the system), simplified accounting because of the automatic daily totals fur-

(*Continued on page 356*)

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MECHANIZED SELLING

(*Continued from page 355*)

nished by the tabulators at the check-out counters, and over-all operating expenses about 10 to 15 per cent lower than those for conventional stores. Some rather large-scale plans are being made for these stores, as indicated by the intention to have about 100 Keedoozle stores in the New York area by 1954. More intriguing, however, is the estimate that the basic system is being studied for application to stock rooms, parts warehouses, drug and hardware merchandising businesses, and similar establishments in which many small and miscellaneous items must frequently be assembled into groups.

In sharp contrast to this gigantic aggregation of automatons is the Food-O-Mat, a self-service store having no intricate or moving mechanisms and mechanically so simple that it is doubtful if the term "machine" can be legitimately applied to it, even though the underlying idea has been patented. In essence, the mechanism of this store is a deep inclined plane about 75 feet long which is cut up into a series of chutes of adjustable width by means of inverted T sections. Each chute is loaded with a line of cans on their side, or with any other article that can roll or slide down the incline. As a customer picks up the bottom item in the chute, the remaining stock moves down to fill the gap, and a group of employees replenishes the supply from the top, as required. Below the supply chute is a return chute for use by those customers who change their minds.

In both Food-O-Mat and Keedoozle stores labor costs are minimized since the task of keeping the supply of goods at the proper level is rendered easier by separating the stockpiling and display functions, and by physically removing stocks from the areas traversed by the customers. In the case of the conventional unit vending machine, however, labor saving is not ordinarily the obvious incentive, for in some fields at least, the over-all cost per sale is no lower than for those cases in which sales are made by human beings. More frequently, the immediate reason for mechanized selling is that machines open up new sales outlets. A vending machine will operate without complaint in places and under conditions that an American clerk would not be likely to endure. The machine will operate at all hours of the day or night, on Sundays, and on holidays, in gasoline stations and subways, on busses and trains. Undoubtedly, the trend toward shorter hours and the five-day week for all types of workers favors their use, as does, in a far more basic way, the high cost of human labor in our economy.

Quite aside from technical reasons, there is little place for a coin machine in China, for example, except as a novelty. The same can be said of almost any area where the cost of building complex machinery is

(*Concluded on page 358*)

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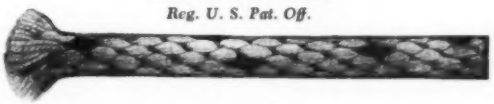

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MECHANIZED SELLING

(Concluded from page 356)

relatively higher, and the cost of maintaining a human being relatively lower than in the United States. "Modernizers of China," says John K. Fairbank‡ (and he might just as well have named Egypt, Italy, or dozens of other countries as well), "in their attempts to introduce the machine have constantly run up against the vested interest of Chinese man power, since in the short run the machine appears to be in competition with human hands and backs."

As with many other technical developments, the inherent promise of the vending machine is that it will free human labor from routine tasks where man, in effect, acts like a machine, else the substitution could not be made. The greater utilization of human creativeness is one of the brighter potentialities which can be fulfilled – when machines displace people in functions of automatism. Those persons who are thus freed from routine operations become available for other jobs where judgment, ingenuity, experience, and knowledge of personality are needed and which, therefore, cannot be mechanized. Of course there is the inherent danger that some will lack the flexibility and the ability to make the change that is part of the dilemma of the times, a Twentieth-Century aspect of the struggle for existence.

‡ *The United States and China*, page 30 (Cambridge: Harvard University Press, 1948), $3.75.

GLASKOGELS

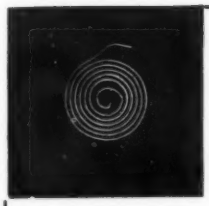
(Continued from page 336)

the appearance of australites far from volcanic sites might be explained by secondary transportation, as, for example, on ice floes or by water generally.

But Suess, the geologist, pointed out that all these "tektites" (he coined the word as a general term for moldavites, schonites, and australites) invariably made their appearance in geologic layers of a certain age, near the end of the Tertiary period. Suess had a wrong guess as to the number of years elapsed since then (we now date these layers as having been formed some 400,000 years ago) but his geological definition was correct. The schonites from Sweden and the australites from the sixth continent, and of course his own native moldavites from Bohemia and Moravia, were always found in layers dating from the end of the Tertiary period. The few exceptions that came to light could be explained as strays, and in some of these cases a secondary transportation by water actually was involved. Human agencies accounted for some others, and the activities of earthworms for still others.

What Suess did not know was that the distribution of all tektites discovered in and since his time follows three different "great circles." This fact alone points to the meteoric origin of tektites. One of the first supporters of Suess was a Dutch scientist, Rogier Diederik Marius Verbeek, who worked on the small island of Belitong or Billiton, situated between Borneo and Sumatra and an important possession of the Nether-

(Continued on page 360)



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GLASKOGELS

(*Continued from page 358*)

lands because of its tin mines. While digging for tin ores, Verbeek brought to light astonishing numbers of "billitonites" again from geologic layers whose age corresponded to that in which the other finds were made. Many of the billitonites were spherical or near spherical so that the Dutch (including Verbeek) called them "glass-spheres," or, in their own language, *glaskogels*. Verbeek wrote a book about the glaskogels of Billiton, compared them with the australites and the other tektites and finally ventured a guess about their origin. There could be little doubt that they had to be meteorites. But since they resembled obsidian so closely, it was quite probable that they had been volcanic originally. Might it not be possible that they were volcanic bombs, just as Darwin had said, but from the craters of the moon?

Geologists read this daring thought with astonishment and decided to obtain further information about certain things from their astronomical colleagues to determine the likelihood of Verbeek's conjecture. Many an astronomer found himself invited for dinner by his colleagues in the university's department of geology. And under questioning the astronomers would have to say that a body would need an escape velocity of roughly one and a half miles per second to leave the moon and its gravitational field. Because of the orbital velocity of the moon itself, a little would have to be added to that figure for the body to reach the earth. One would have to assume an escape velocity of about two miles per second if a volcanic bomb from a lunar crater were to reach the earth. Whether a volcano, here or on the moon, can shoot "bombs" with such a velocity was something that the astronomers were not prepared to say. But they could tell that they were no longer completely convinced that all the round holes on the moon (which had been called "craters" because of habit and tradition) were really volcanic craters. In fact, more and more astronomers began to believe that many of the moon's craters were impact craters, themselves, caused by meteorites falling on the moon's surface.

Following such discussions with their astronomical colleagues, the geologists made a few calculations and decided that they also were not prepared to say whether a volcano could shoot out bombs with a muzzle velocity of two miles per second. Moreover, if the lunar craters were not even certified as being extinct volcanoes, there was little use in pursuing Verbeek's proposal. Thus the matter came to rest in the days just before World War I.

Since then the story has not developed much further. The discovery that all tektite sites are arranged along three great circles has added one more proof to Suess's original assumption that they were meteoric glass. Such additional proof was really not needed as far as the nature of the tektites is concerned, but it indicates that all tektites are the result of a very few highly special meteoric showers.

Recently, Harvey H. Nininger has offered an interesting suggestion which could salvage Verbeek's

(*Concluded on page 362*)

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GLASKOGELS

(*Concluded from page 360*)

main idea. Nininger's idea is that the tektites did actually come from the moon under somewhat unusual conditions during the creation of a lunar impact crater. Most astronomers now believe that most lunar craters are impact craters, and the problem of whether a volcano could eject matter fast enough is still not quite settled. But at the point of meteoric impact on the moon enough energy is liberated to provide matter with the necessary escape velocity. Now if the point of impact is in or near the bed of old lunar obsidian flows, pieces of such obsidian might be hurled into space with the necessary velocity. Making all these assumptions, Dr. Nininger proposed to regard the tektites as "lunar impactites."

It is an amusing idea, but there is little that speaks in favor of it and at least two facts speak against it. If the tektites had originated in the manner pictured by Dr. Nininger, there would be a random distribution, whereas the distribution is found to be along only three great circles. Likewise, according to the Nininger hypothesis, there would be a random distribution through time. According to our best knowledge, however, all tektites came from space within a very short time interval, geologically speaking. They seem to be the result of a unique event which took place at a time when man had just acquired the knowledge of simple tools. Undoubtedly a suitable explanation for the origin of tektites will be forthcoming. But until such time as science provides a satisfactory hypothesis, the presence of the green glassy shards of Bohemia, Sweden, and Australia poses a problem for which no adequate solution has been found during man's recorded history. From tektites to Verbeek's glaskogels, these objects will continue to remain mysterious, until a geologist, an astronomer, or some other scientist provides an answer.

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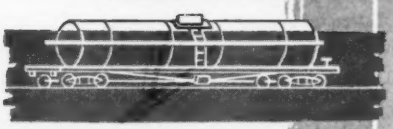

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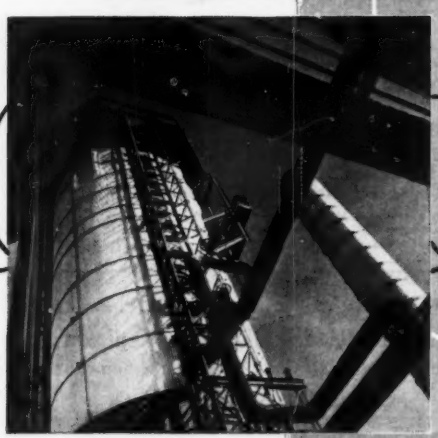

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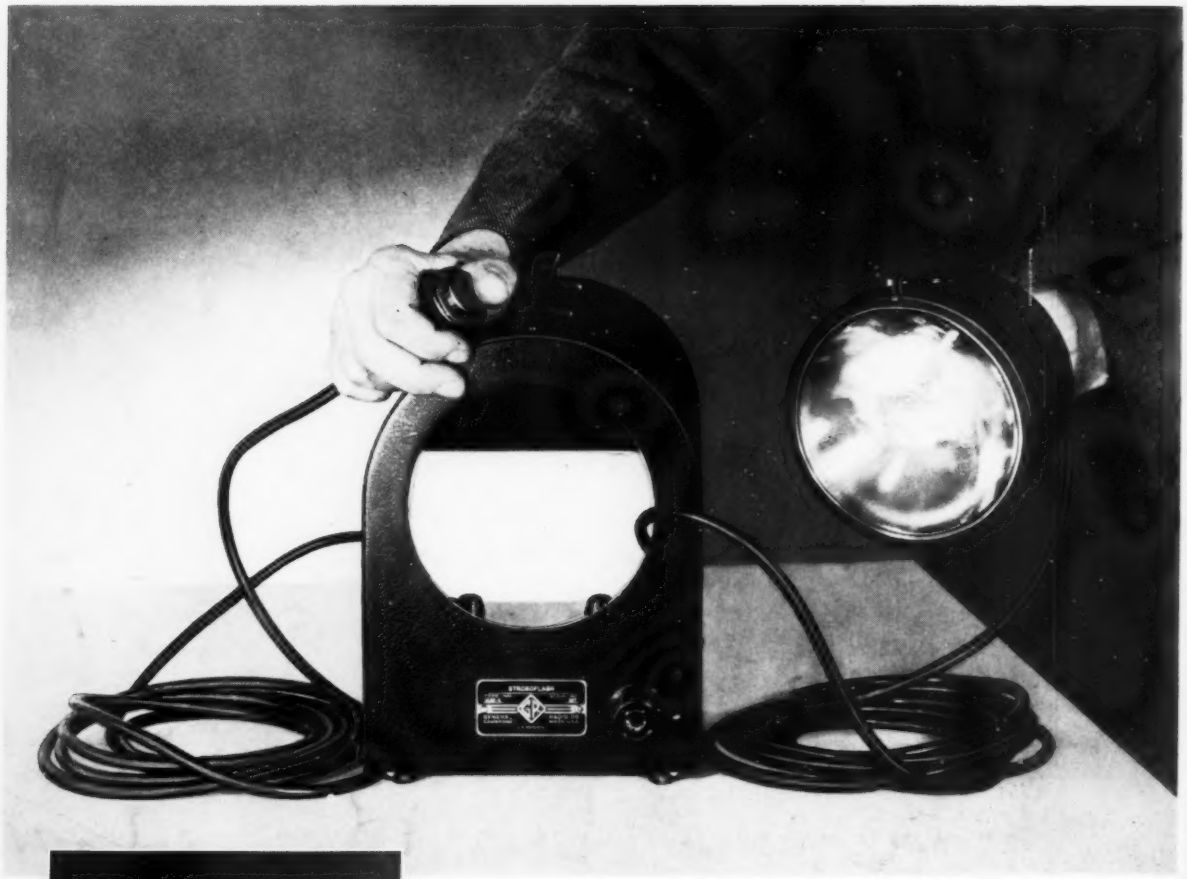

The STROBOLUME normally is housed in the power-supply case, weighing, complete, 18½ pounds. The sealed-beam lamp and its case are removable from the supply assembly for use at the end of a 10-foot cable. The lamp housing is equipped with a standard tripod socket.

TYPE 1532-A STROBOLUME $225.00

TYPE 631-BS18 STROBOTAC (special, with flashing rate of 60 to 14,400 per minute) **$170.00**

Let us send full details.

WRITE FOR THE STROBOLUME BULLETIN

for *Extra HIGH* Light Intensity in *Slow-speed* Stroboscopic Applications

THE new STROBOLUME is designed to give an extra-brilliant, short-intensity stroboscopic light for observation of very slow-moving objects or machine operations . . . much slower than can be observed with our other Stroboscopes.

It is particularly suited to single- or multiple-flash stroboscopic photography, having a flash duration of approximately ten millionths of a second . . . about *one-twentieth* of that of the average commercial "speed lamp."

The STROBOLUME can be operated in several ways. It is equipped with a cord and push-button switch for firing at hand-controlled times. With an external contactor its flashing may be timed to correspond to the speed of a rotating shaft. When so used it will flash up to 1200 times per minute.

A special slow-speed STROBOTAC is available for operation with the STROBOLUME at flashes of from 60 to 1200 per minute. The STROBOTAC alone has a speed range of 60 to 14,400 per minute.

At flashing rate up to 45 per minute, the STROBOLUME may be operated continuously. At other speeds, up to its maximum of 1200, it can be operated for short periods before a built-in automatic circuit breaker calls for a brief rest period.

Many new fields for the stroboscopic study of slow moving machines are opened to research, design and production with the STROBOLUME.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

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